Global Ocean Monitoring: Recent Evolution, Current Status, and Predictions

Prepared by

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http://www.cpc.ncep.noaa.gov/products/GODAS/

This project to deliver real-time ocean monitoring products is implemented by CPC in cooperation with NOAA Ocean Climate Observation Program (OCO)

Outline

- Overview
- Recent highlights
  - Pacific/Arctic Ocean
  - Indian Ocean
  - Atlantic Ocean
- Global SST Predictions

Overview

▪ Pacific and Arctic Oceans

- ENSO-neutral conditions continued during Nov 2012.
- The consensus forecast favors ENSO-neutral conditions to continue into the Northern Hemisphere winter 2012/13 and spring 2013.
- Negative PDO phase strengthened with PDO=-1.2 in Nov 2012, and NCEP CFSv2 predicted negative PDO phase would continue into next spring.
- For the Arctic as a whole, ice growth in November was faster than average.

▪ Indian Ocean

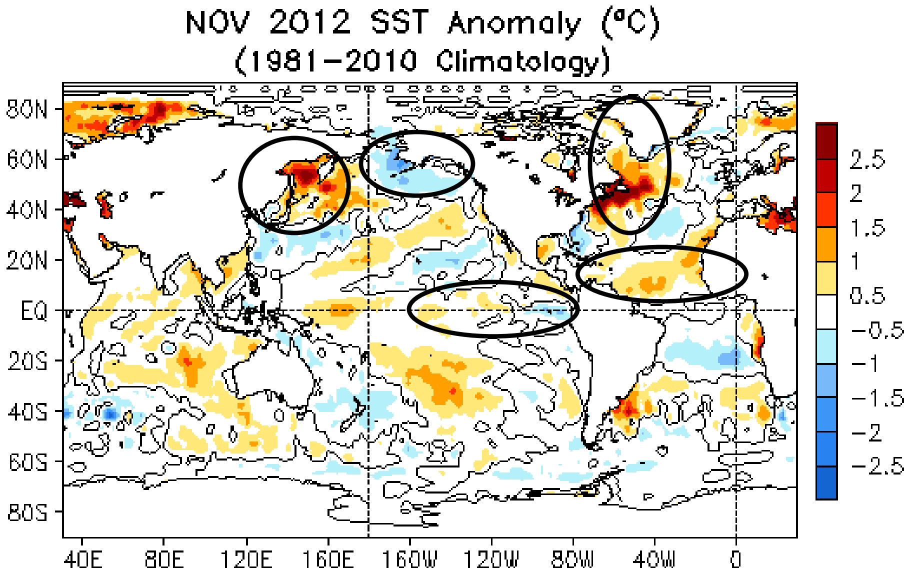
- Indian Ocean Dipole was near-normal in Nov 2012.

▪ Atlantic Ocean

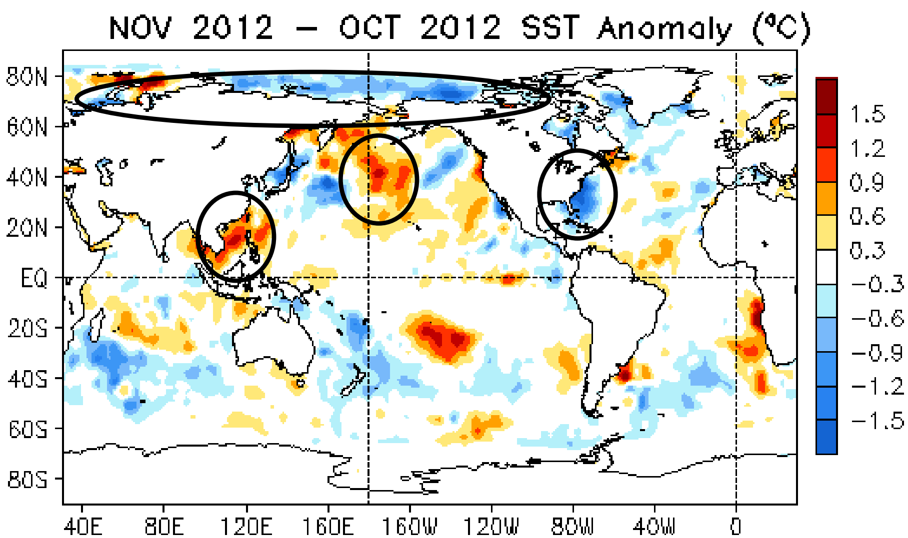
- Negative NAO phase weakened with NAO=-0.74 in Nov 2012. The persistent negative NAO phase in the past 7 months contributed to a strong warming in high-latitude N. Atlantic.
- 2012 Atlantic hurricane season has 19 tropical storms (TSs), 10 hurricanes (Hs) and 1 major hurricanes (MHs), which is well above the average for TSs and Hs and below average for MHs.
- In terms of accumulated cyclone energy (ACE), tropical cyclone activity in the Atlantic basin during 2012 was about 140% of the 1981-2010 median, which largely agrees with the NOAA ACE Outlook (75-135%).

Global Oceans

Global SST Anomaly (^0C) and Anomaly Tendency



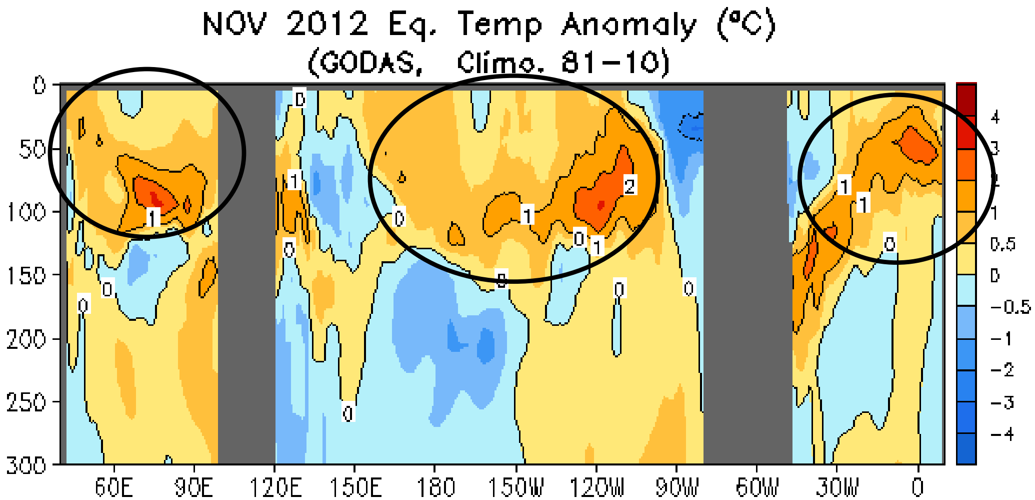
- SST was near-normal in the central-eastern tropical Pacific.
- Positive SST anomalies presented north of Japan, along the Gulf Stream, and in the subtropical North Atlantic .
- Negative SST anomalies presented in Bering Strait and Gulf of Alaska.



- A cooling tendency presented in the Arctic Ocean, near the coast of America Southeast.
- A warming tendency was observed in South China Sea and central N. Pacific.

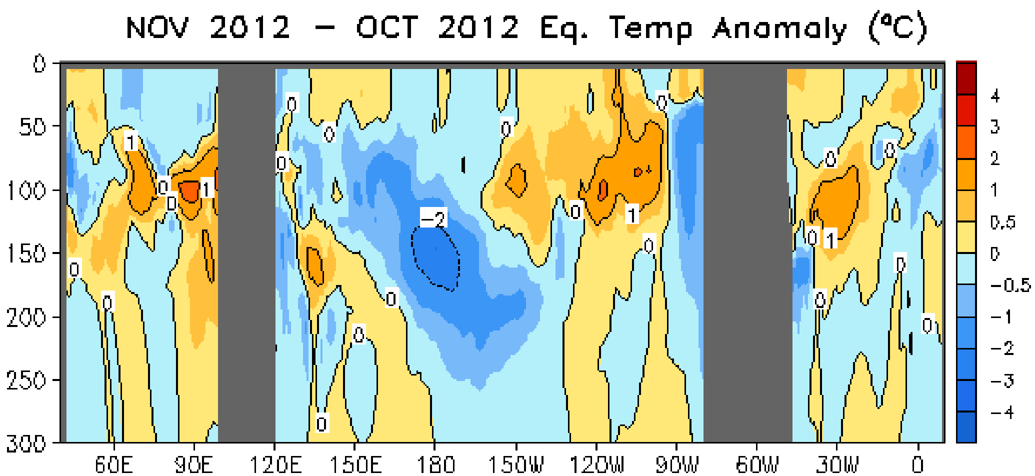
Fig. G1. Sea surface temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2^{O}S-2^{O}N



- Positive temperature anomalies continued to occupy near the thermocline in the equatorial Pacific Ocean.

- Positive anomalies dominated at the upper 100m of equatorial Indian and Atlantic Ocean.

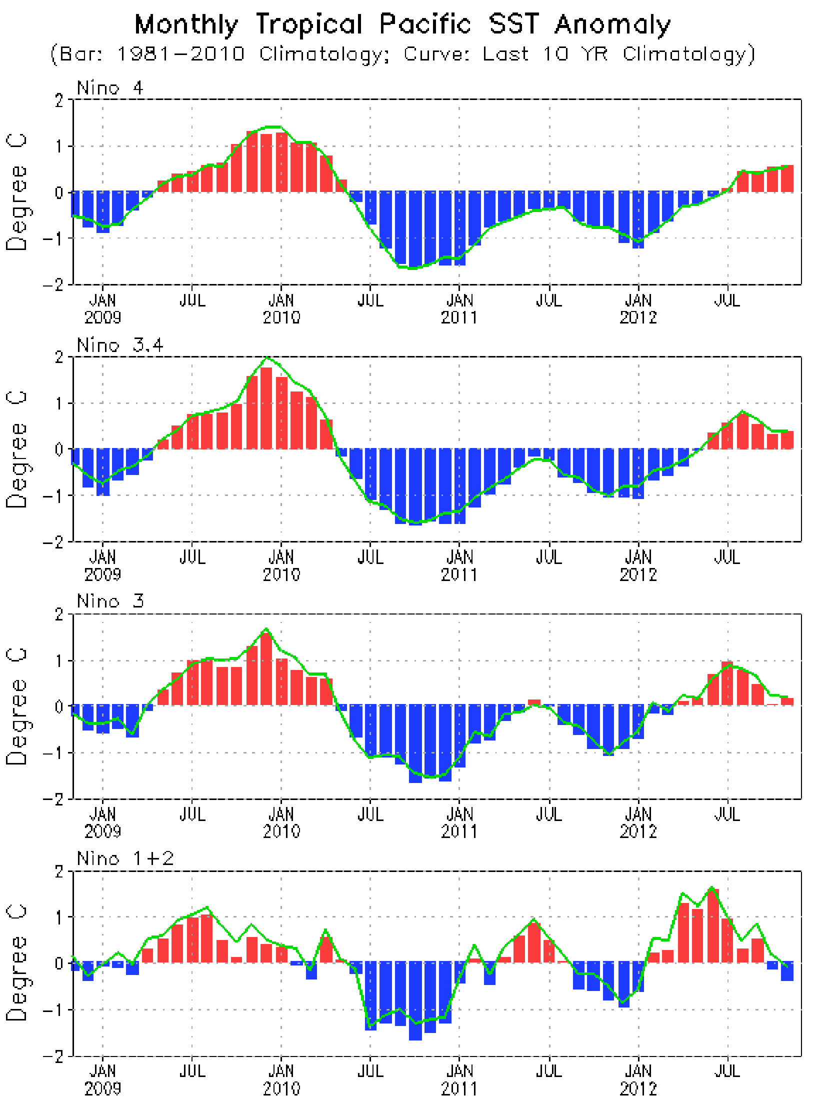


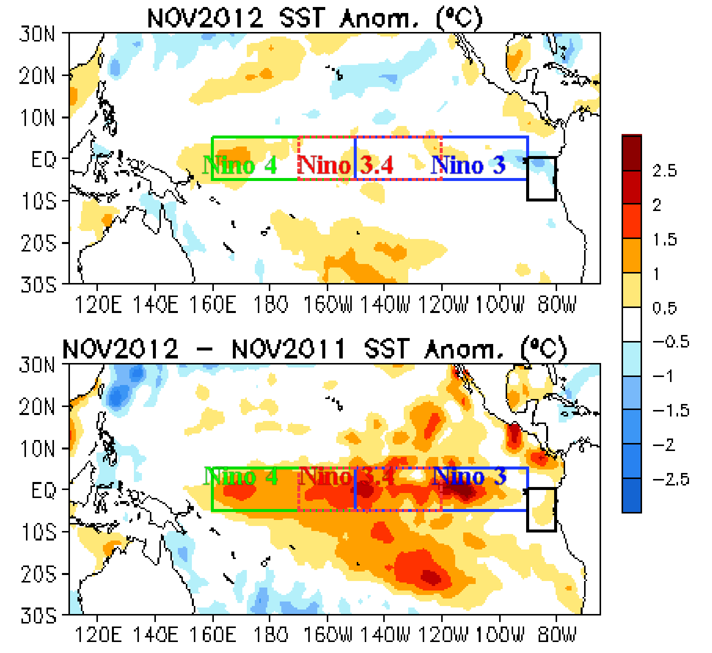
- A cooling (warming) tendency was observed in the western (eastern) Pacific Ocean near the thermocline, largely due to propagation of downwelling and upwelling oceanic Kelvin waves (slide 11).

Fig. G3. Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM. Anomalies are departures from the 1981-2010 base period means.

Tropical Pacific Ocean and ENSO Conditions

Evolution of Pacific NINO SST Indices

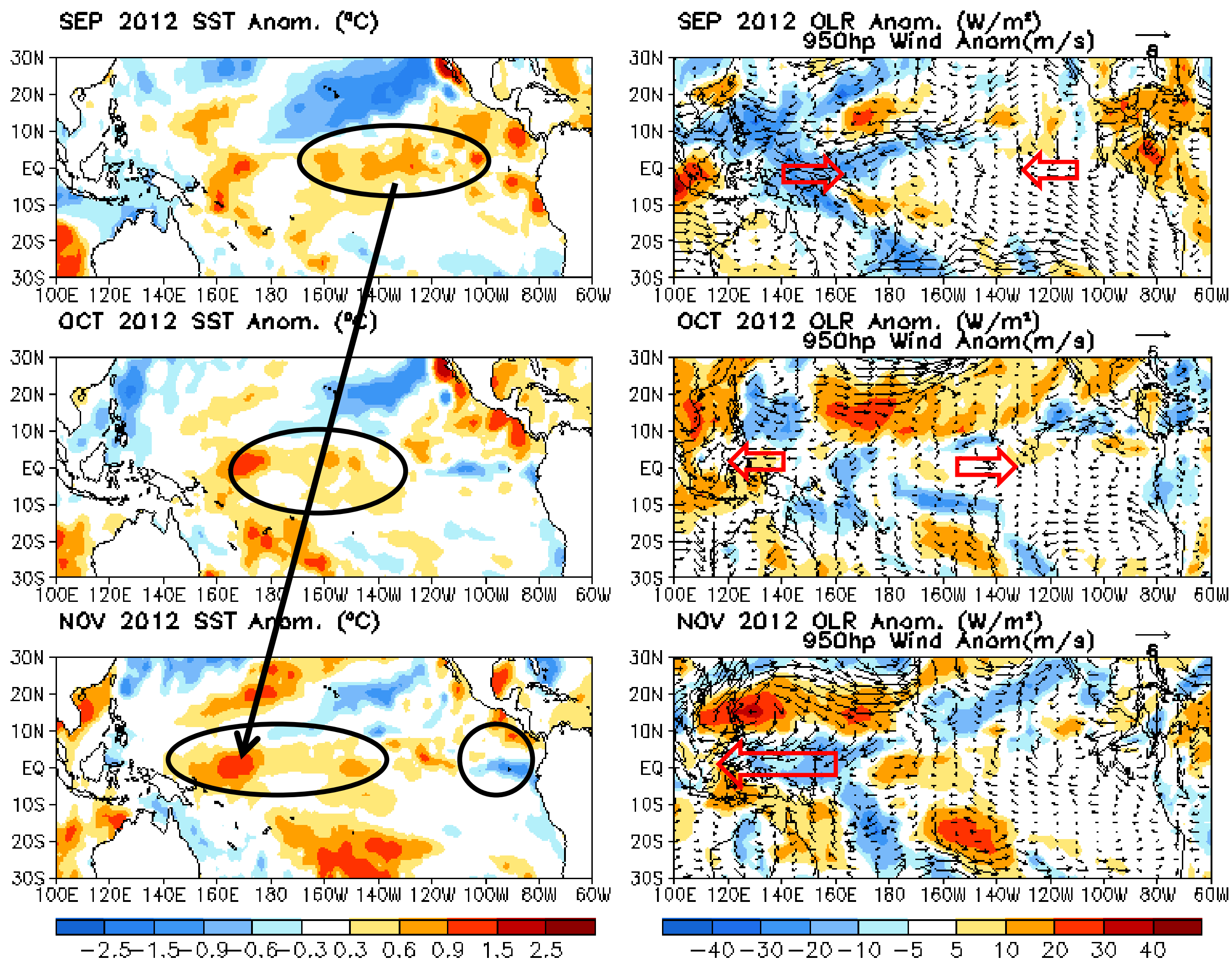




- All Nino indices were near-normal except NINO 4 = 0.54ºC. .
- NINO 3.4 was above 0.5ºC in Jul-Sep 2012, which has a too short duration to meet El Nino definition.
- The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v3b.

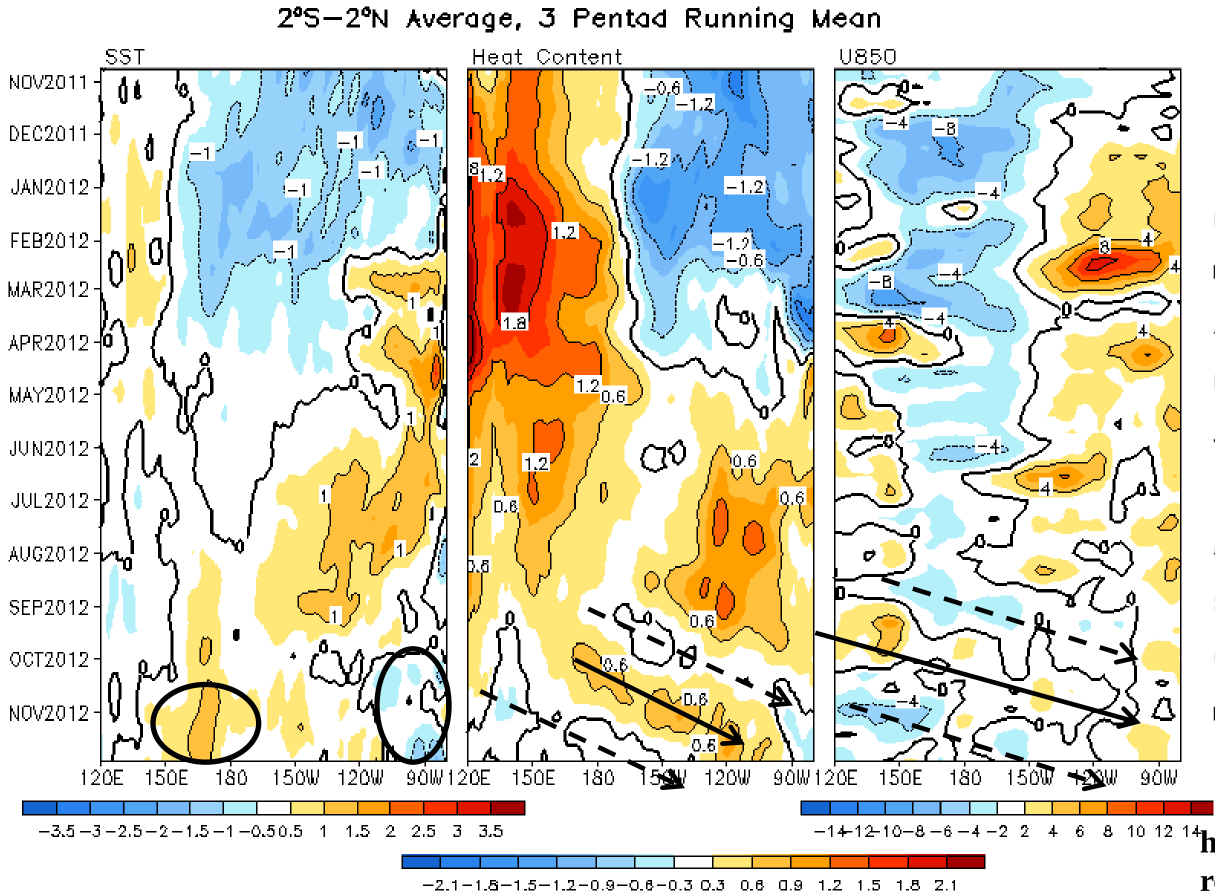
Fig. P1a. Nino region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (ºC) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 (bar) and last ten year (green line) means.

Last Three Month SST, OLR and 925hp Wind Anom.

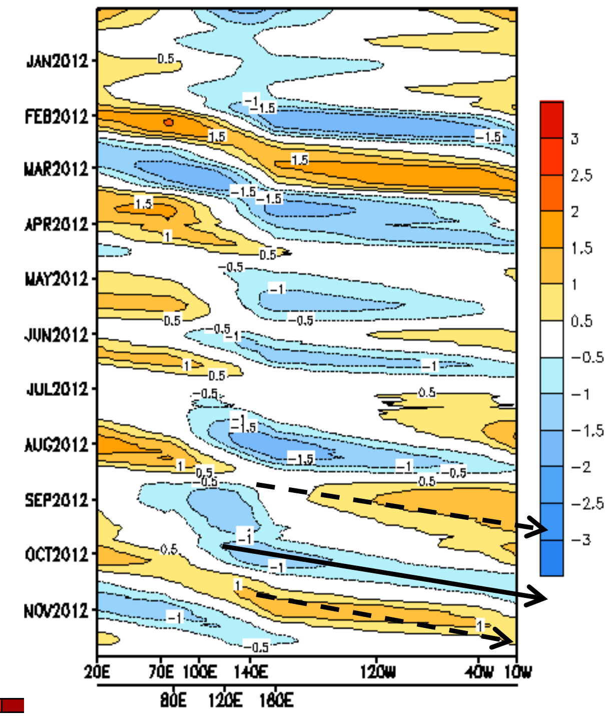


- The center of positive SSTA shifted westward, and below-normal SST developed in the far E. Pacific.
- Atmospheric circulations were near-normal with strong intra-seasonal variability in Aug-Oct 2012.
- Strong easterly wind anomalies developed in the western tropical Pacific in Nov 2012 associated with anomalous anticyclone near Philippine.

Equatorial Pacific SST (°C), HC300 (°C), u850 (m/s) and OLR(W/m^2)Anomalies



CPC MJO Indices

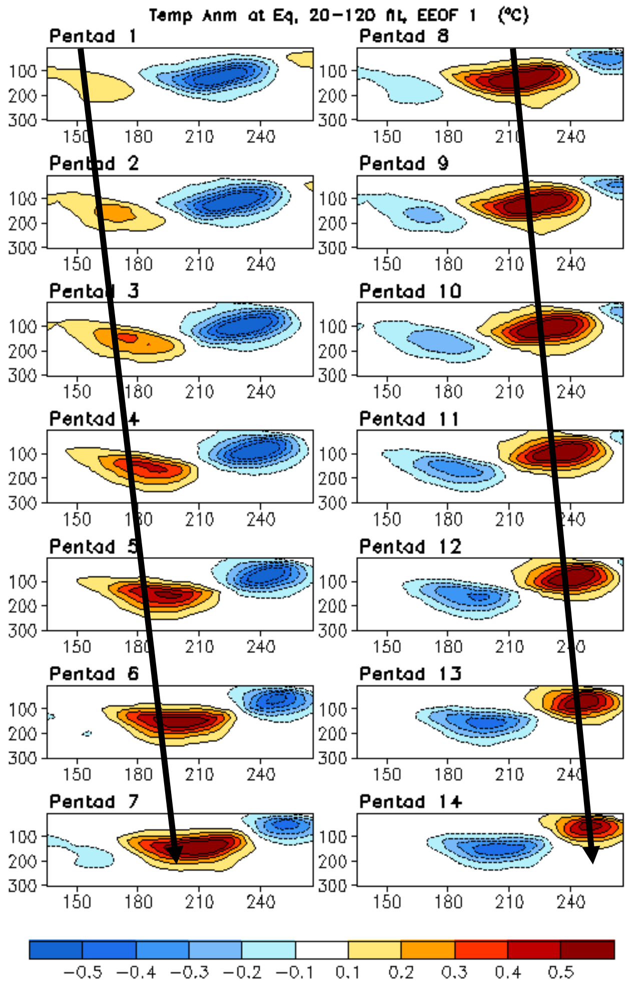


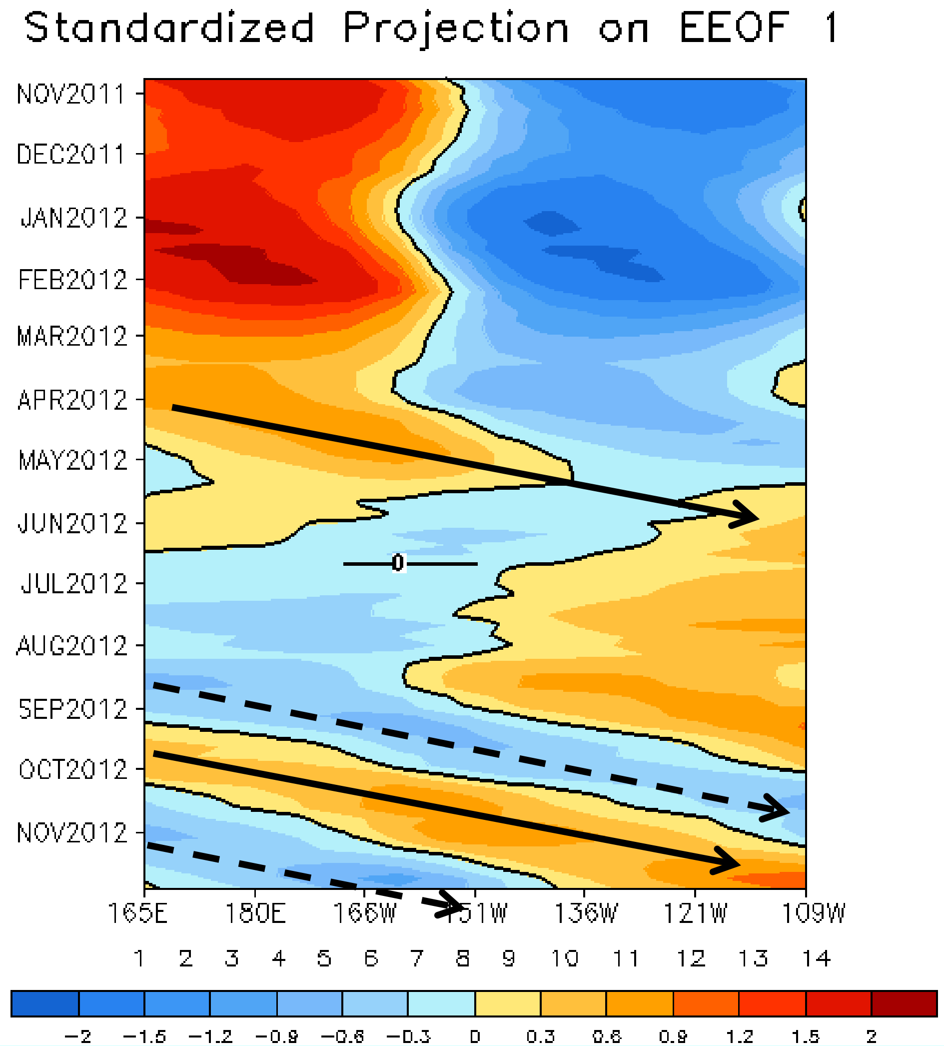
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_mjo_index/mjo_index.shtml

- Positive SSTA more than +1°C persisted near 170E, while negative SSTA confined east of 110W.
- Positive HC300 anomalies propagated eastward and reached 110W, due to downwelling oceanic Kelvin waves.
- Easterly wind anomalies emerged in the far western equatorial Pacific in early Nov 2012 associated with the negative phase of MJO (orange color in CPC MJO indices).

Fig. P4. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 2°S-2°N and Outgoing Long-wave Radiation (OLR, right) averaged in 5°S-5°N. SST is derived from the NCEP OI SST, heat content from the NCEP's global ocean data assimilation system, U850 from the NCEP CDAS. Anomalies for SST, heat content and U850/OLR are departures from the 1981-2010 base period pentad means respectively.

Oceanic Kelvin Wave Indices



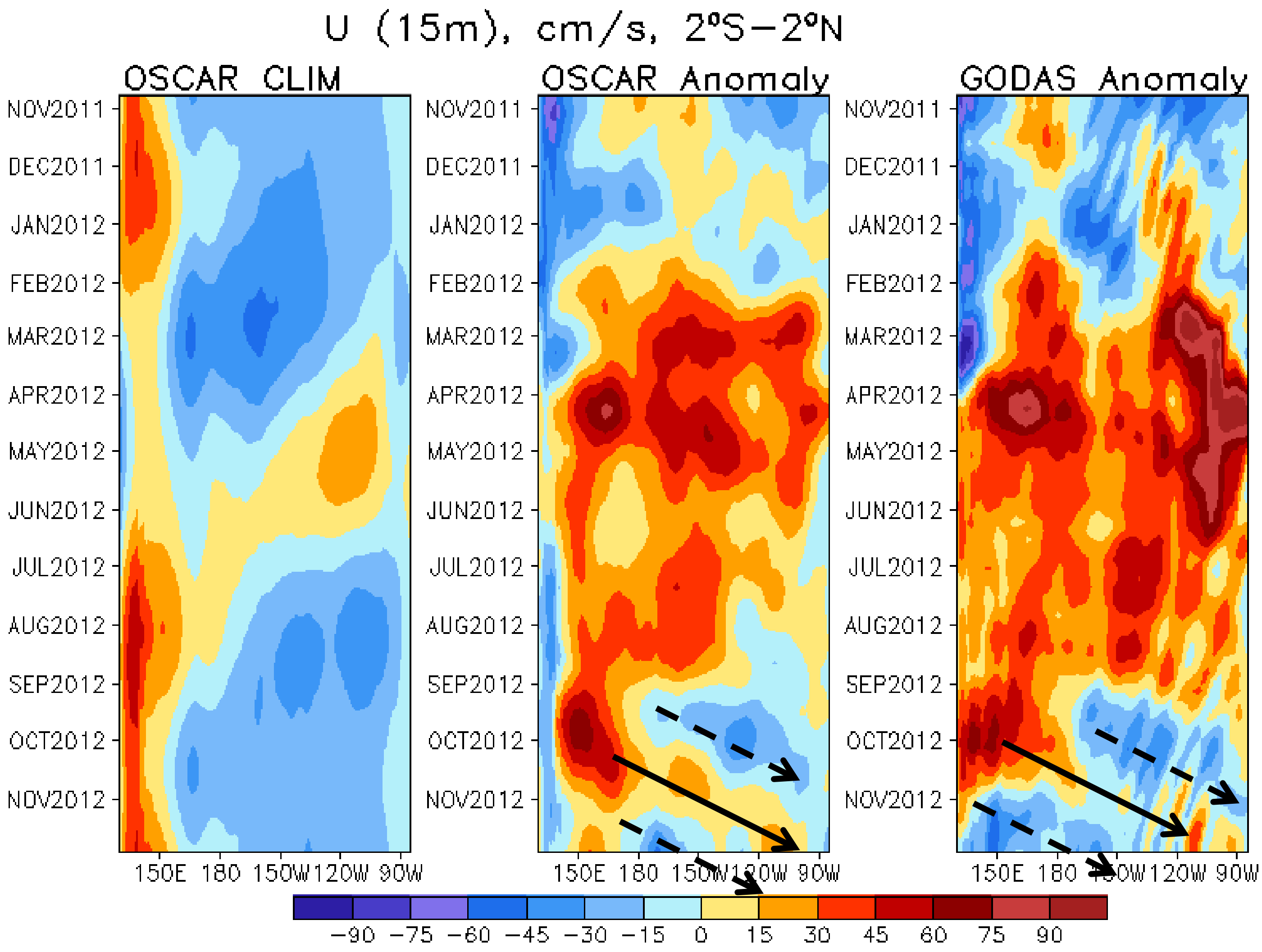


- Upwelling oceanic Kelvin wave (OKW, dash line) emerged in mid-Aug in the W. Pacific and propagated eastward associated with the negative phase of MJO.

- Downwelling OKW (solid line) emerged in mid-Sep in the W. Pacific was associated with the positive phase of MJO, while upwelling OKW initiated in early-Nov in the W. Pacific was associated with the negative phase of MJO.

- Oceanic Kelvin wave indices are defined as standardized projections of total anomalies onto the 14 patterns of Extended EOF 1 of equatorial temperature anomalies (Seo and Xue , GRL, 2005).

Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)

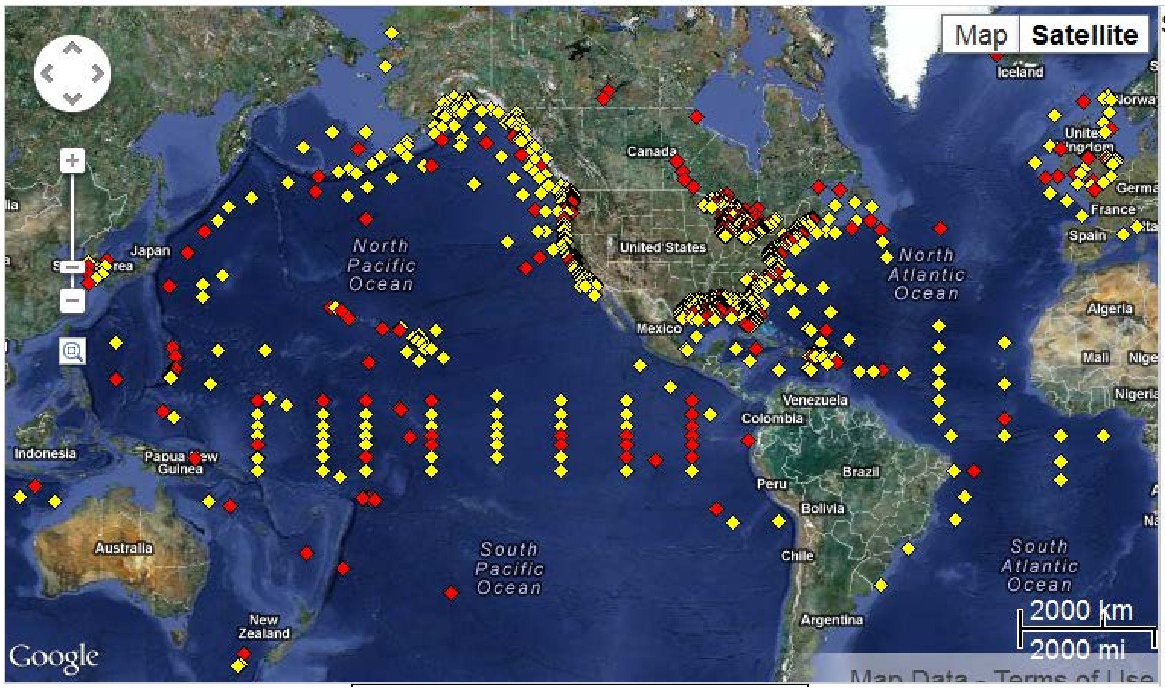


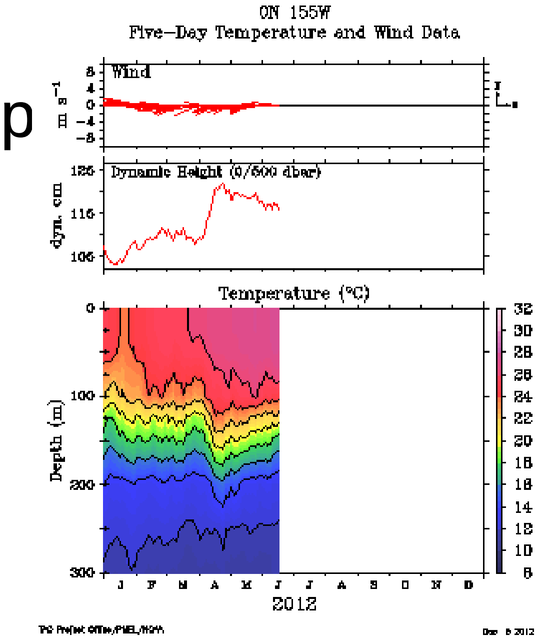
- **Positive (negative) zonal current anomalies were associated with downwelling (upwelling) oceanic Kelvin waves.**

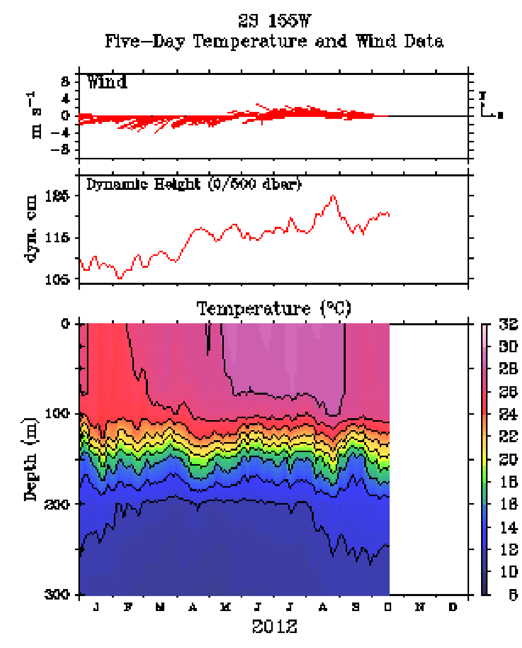
Status of TAO/TRITON Data Delivery

http://www.ndbc.noaa.gov

http://www.pmel.noaa.gov/tao/jsdisp



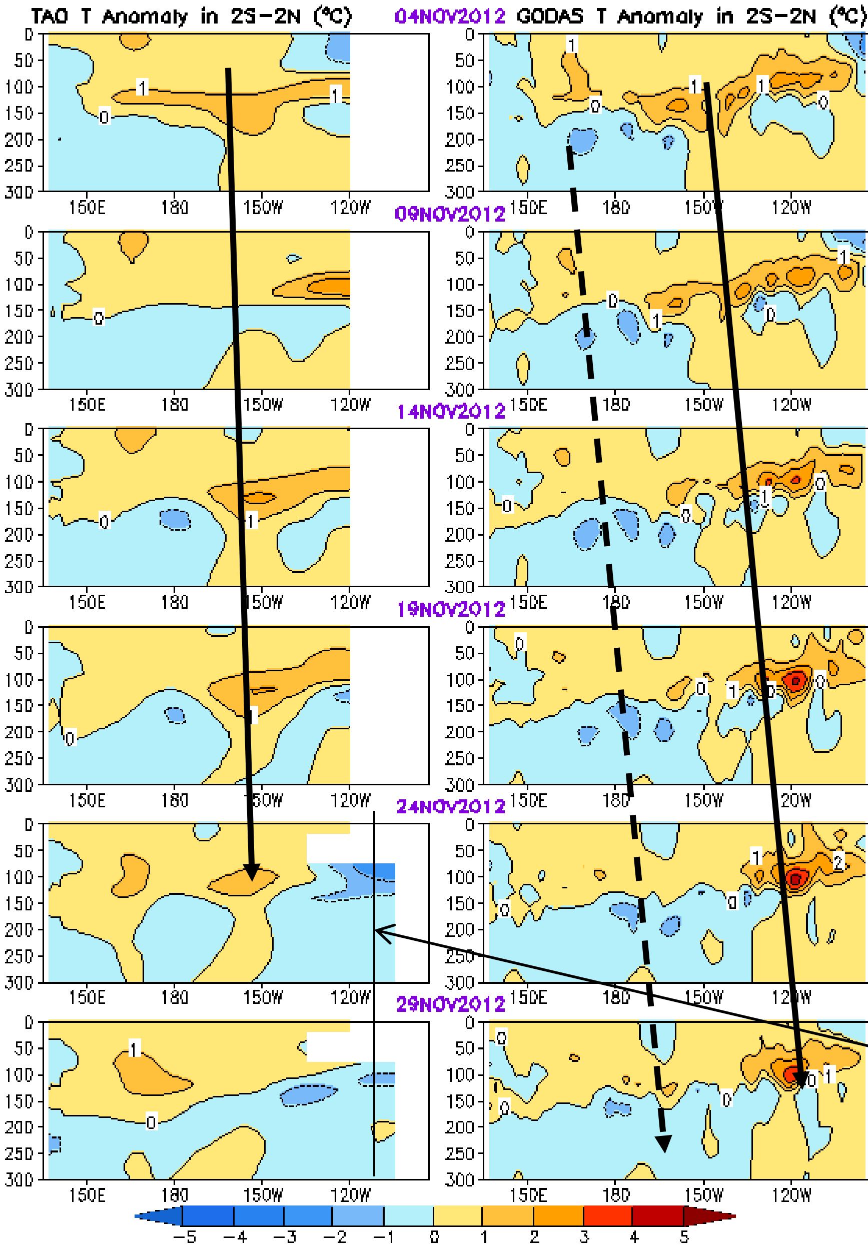




- **The TAO/TRITON array has encountered significant outages, particularly in the eastern third of the array.**
- **The mooring at 155W, 0N has been down since July, while the mooring at 155W, 2S went down in mid-Oct 2012.**

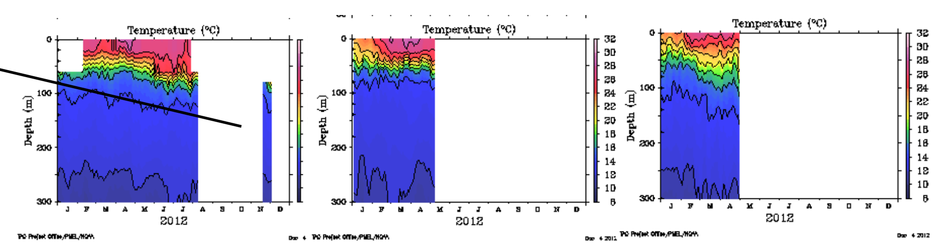
Equatorial Pacific Temperature Anomaly

TAO GODAS

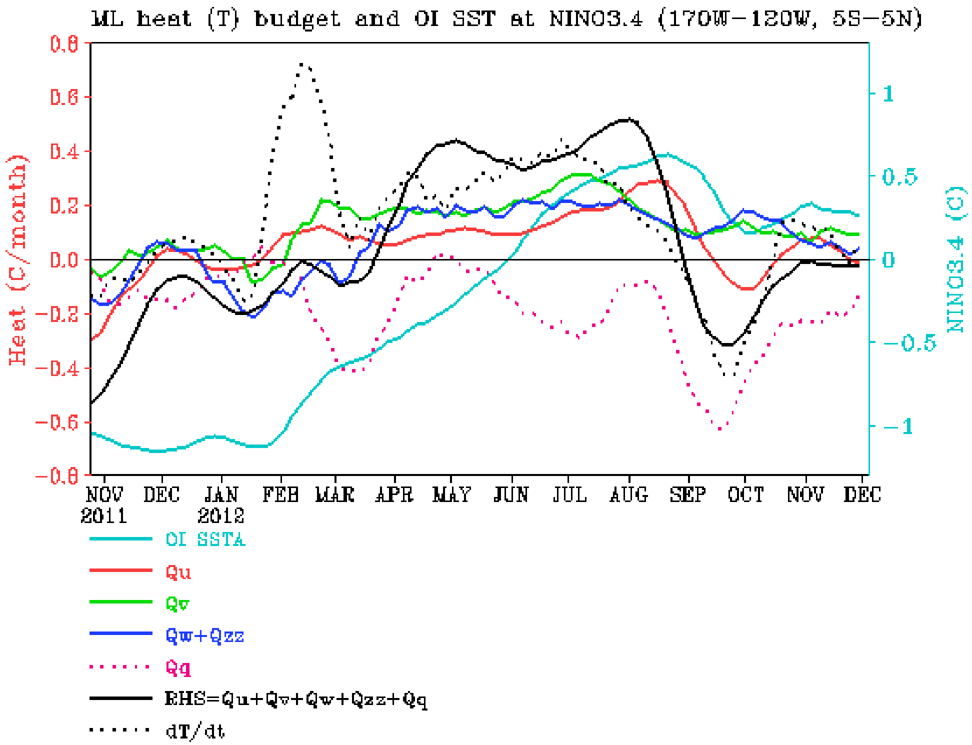


- Positive (negative) temperature anomalies near the thermocline propagated eastward, associated with downwelling (upwelling) OKWs.
- However, the eastward propagation of upwelling OKWs was not clear in TAO data.
- The mooring at 110W, 2N delivered some data during Nov, which indicated that there was a subsurface cooling near 110W in late Nov, while GODAS missed the cooling.

2N 110W 0N 110W 2S 110W



NINO3.4 Heat Budget



- SSTA tendency (dT/dt) in NINO3.4 region (dotted black line) was near zero in Nov 2012, indicating a persistence in NINO3.4.

- All the advection terms were positive, the sum of which was largely in balance with the negative thermodynamical term (Qq).

Huang, B., Y. Xue, X. Zhang, A. Kumar, and M. J. McPhaden, 2010 : The NCEP GODAS ocean analysis of the tropical Pacific mixed layer heat budget on seasonal to interannual time scales, J. Climate., 23, 4901-4925.

Qu: Zonal advection; Qv: Meridional advection;

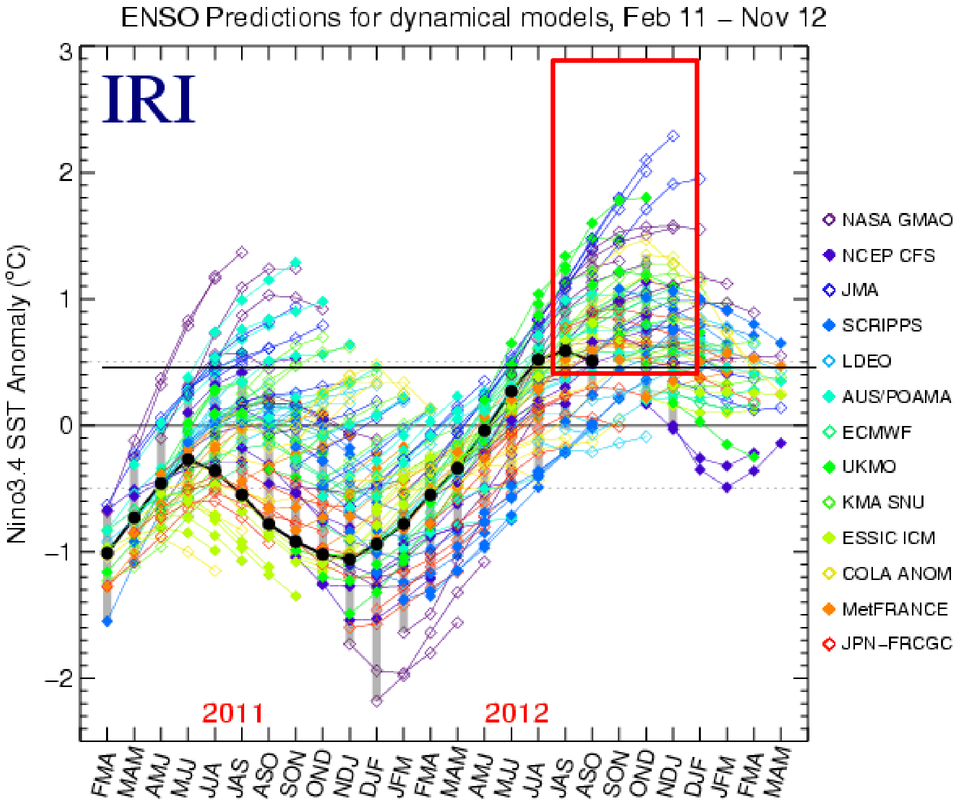
Qw: Vertical entrainment; Qzz: Vertical diffusion

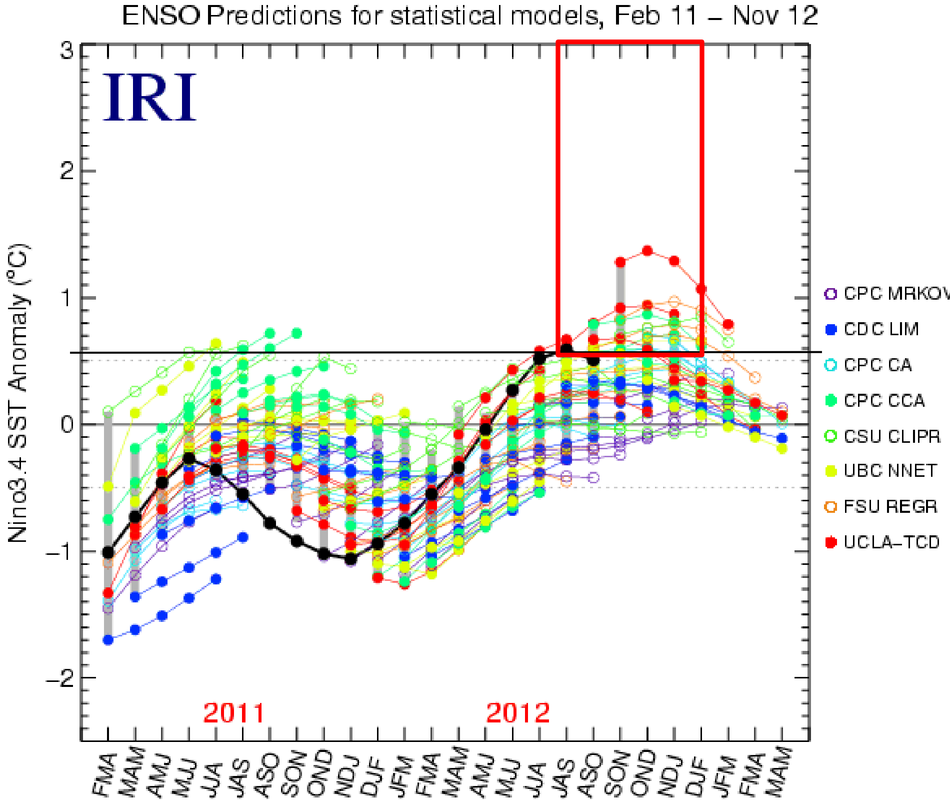
Qq: (Qnet - Qpen + Qcorr)/ρcph; Qnet = SW + LW + LH +SH;

Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

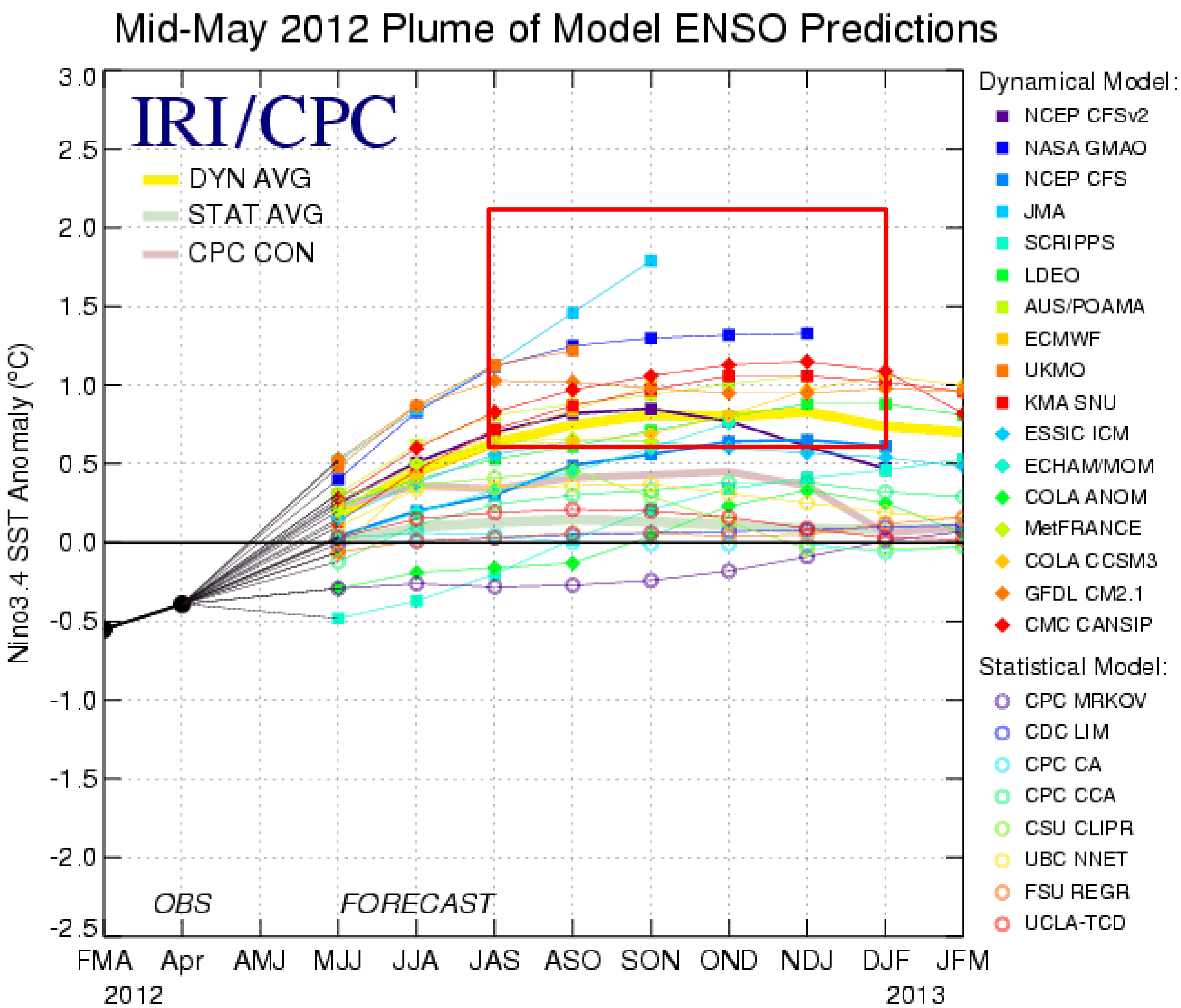
Review of Last 22 Month ENSO Predictions

Summary of Forecasts Issued over Last 22 Months





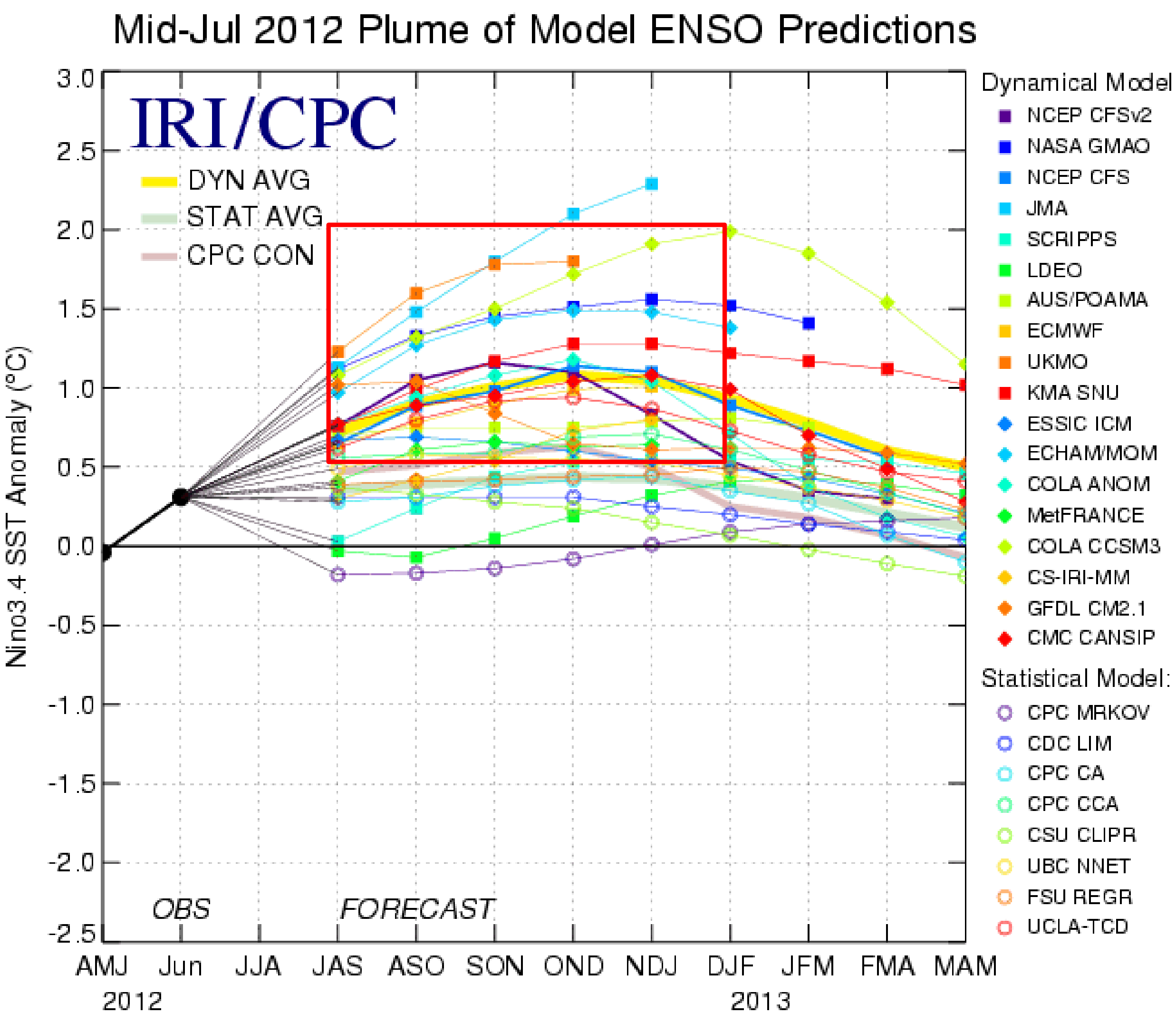
- **Many dynamical models predicted El Nino to develop during fall 2012, and to continue into the 2012/13 winter.**
- **But most of statistical models predicted ENSO-neutral conditions for fall 2012 and winter 2012/13.**



Mid-May Forecasts

Seasons (2012-2013)

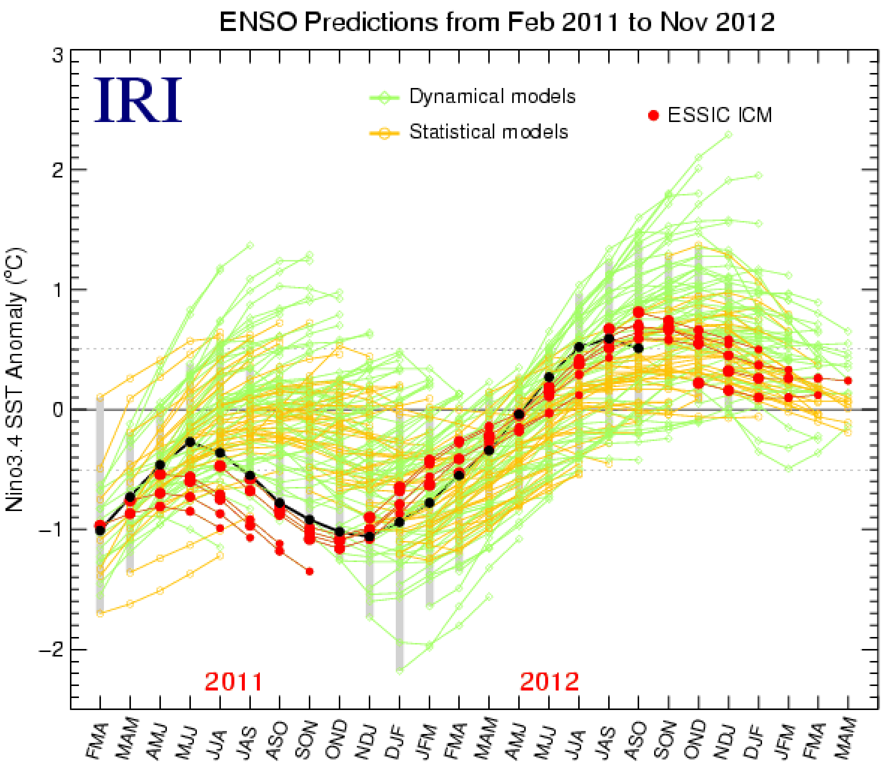
Model	MJJ	JJA	JAS	ASO	SON	OND	NDJ	DJF	JFM
Average, dynamical models	0.2	0.4	**0.6**	**0.7**	**0.8**	**0.8**	**0.8**	**0.7**	
Average, statistical models	-0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1



Mid-Jul Forecasts

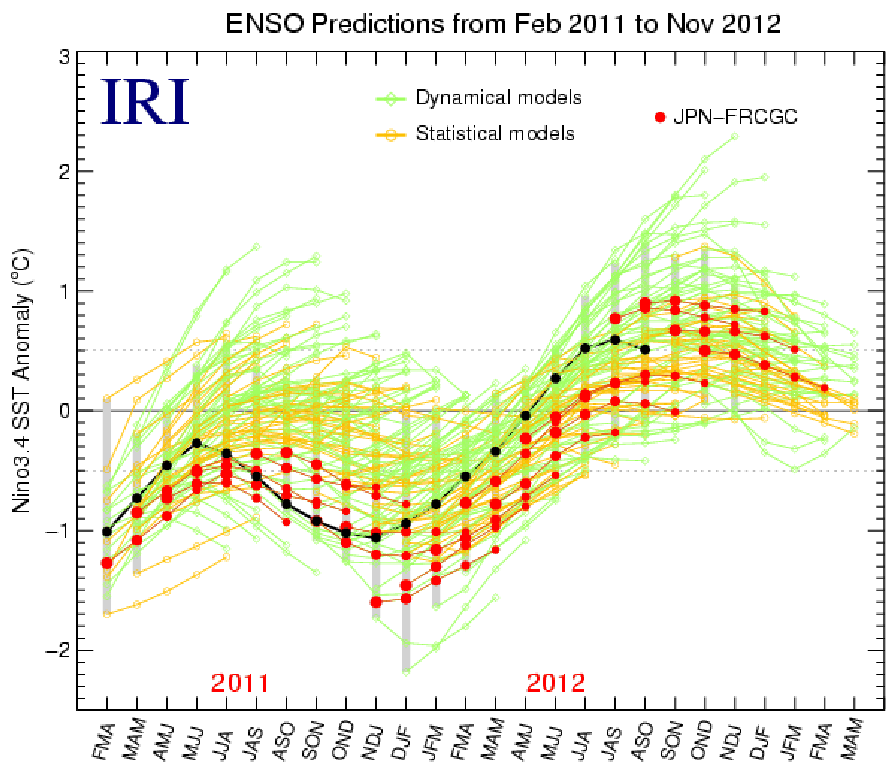
Seasons (2012-2013)

Model	JAS	ASO	SON	OND	NDJ	DJF	JFM	FMA	MAM
Average, dynamical models	**0.7**	**0.9**	**1**	**1.1**	**1**	**0.9**	**0.8**	**0.6**	
Average, statistical models	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.2	0.1



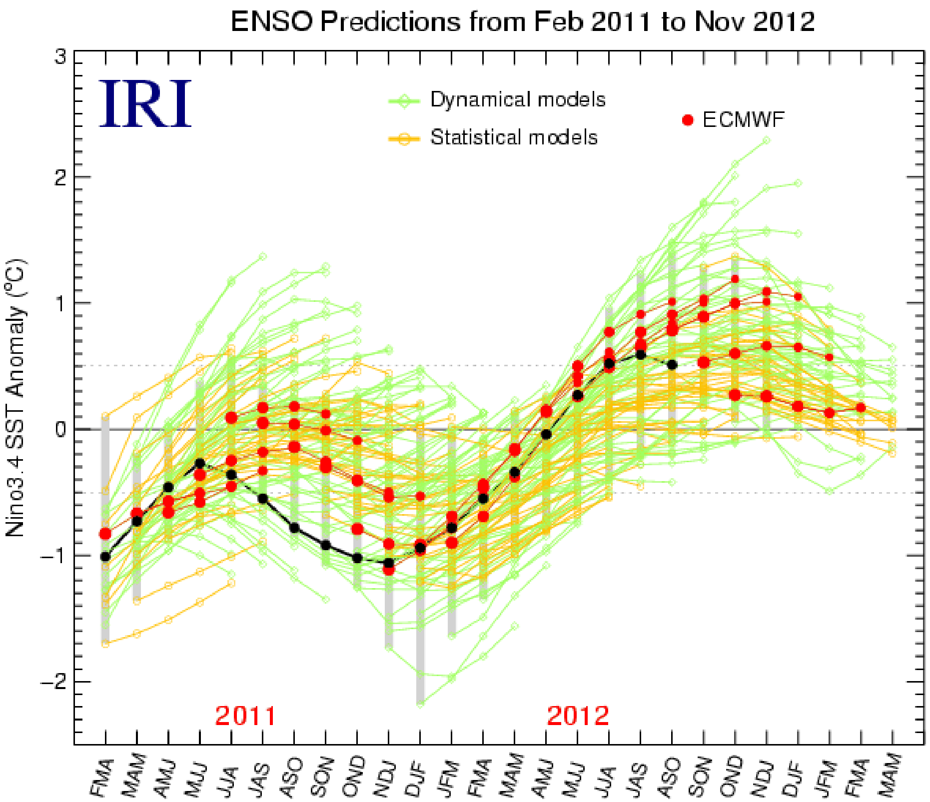
A few Examples

- **ESSIC ICM predicted a borderline El Nino in fall 2012, and then ENSO-neutral conditions for winter 2012/13.**
- **ESSIC also predicted the 2011/12 La Nina quite well.**

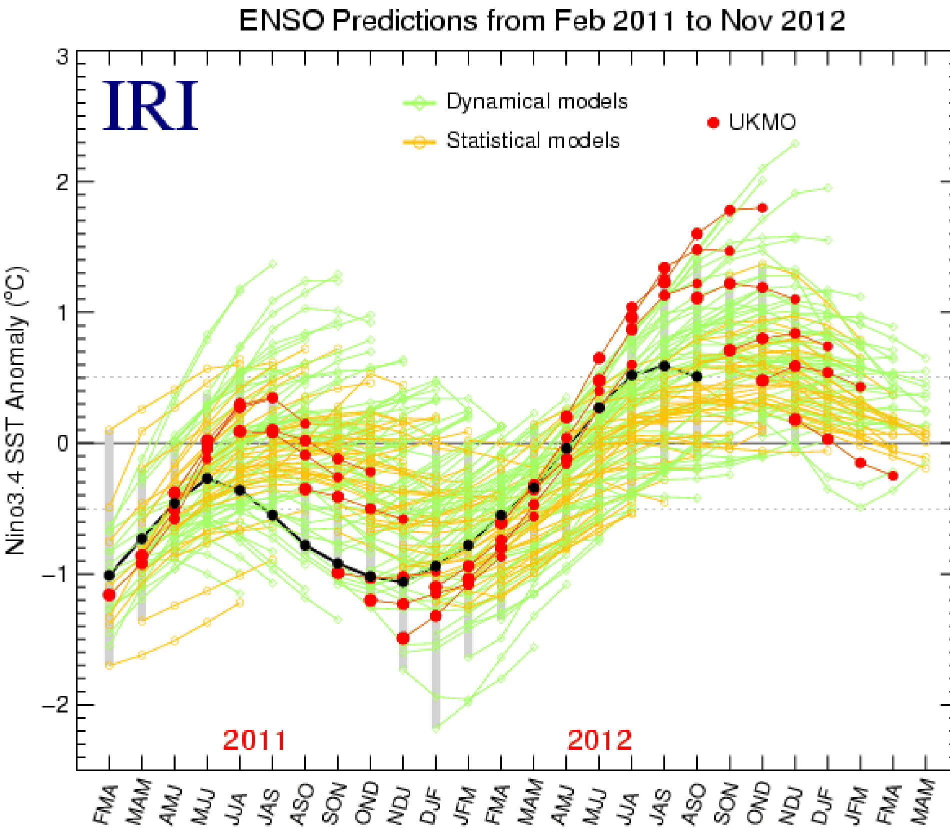


- **JPN-FRCGC predicted a weak EL Nino in fall 2012, and then ENSO-neutral in winter.**
- **The forecast in the first half of 2012 had cold bias.**

A few Examples

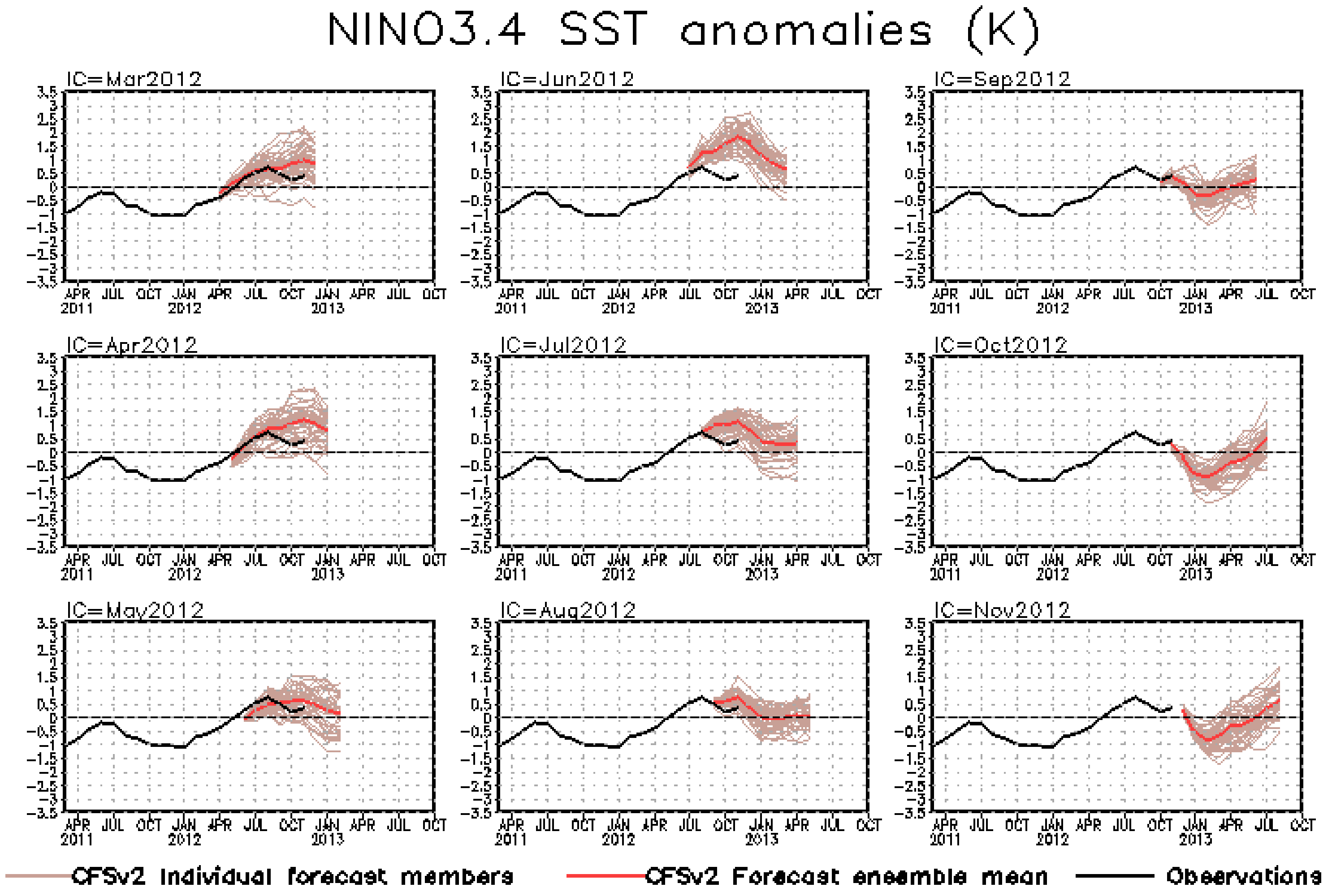


- **ECMWF predicted a weak El Nino in fall 2012 and winter 2012/13, but ENSO-neutral winter from Oct 1 and Nov 1 initial conditions.**
- **It missed the onset phase of 2011/12 La Nina, but successfully predicted the transition from La Nina to neutral.**



- **UKMO predicted a moderate El Nino in fall 2012, and then ENSO-neutral winter from the latest initial conditions.**
- **Similar to ECMWF, it missed the onset phase of 2011/12 La Nina, but successfully predicted the transition from La Nina to neutral.**

NCEP CFSv2 NINO3.4 Forecast



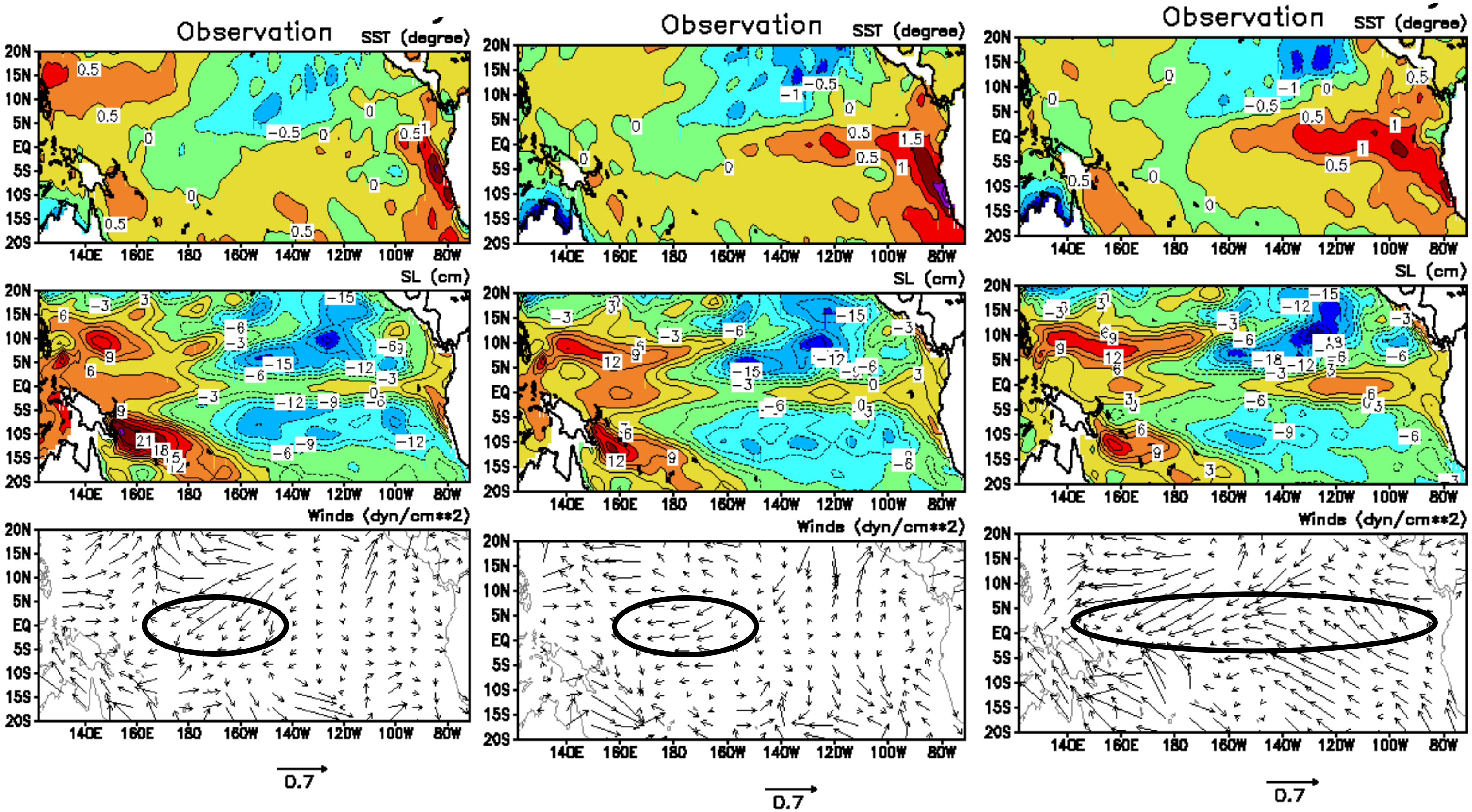
- **CFSv2 predicted a weak / moderate El Nino from Mar-Jul I.C., and then ENSO-neutral conditions from Aug-Nov I.C. for the 2012 / 13 winter.**

May 2012 | Jun 2012 | Jul 2012

OISSTv2

GODAS Sea Level

FSU Wind Stress



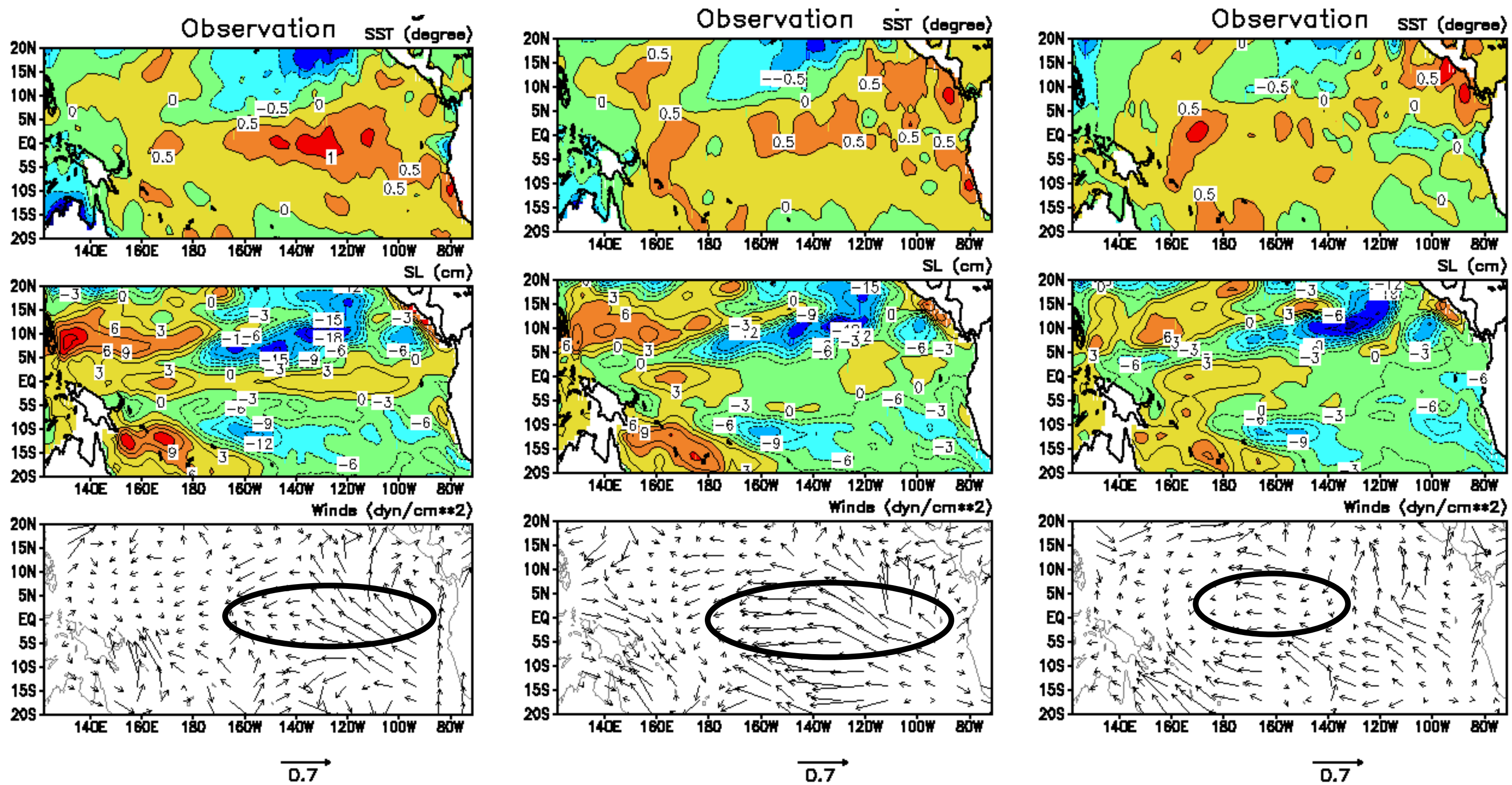
- SST increased rapidly from May to Jul, and El Nino-like conditions presented in Jun-Jul.
- Sea level (SL) was weakly above-normal in the equatorial belt except near Dateline, which indicates there was little coupled growth between SST and SL anomalies.
- Easterly wind anomalies dominated in the central tropical Pacific, unfavorable for El Nino development.

Aug 2012 | Sep 2012 | Oct 2012

OISSTv2

GODAS Sea Level

FSU Wind Stress



- Positive SSTA decreased rapidly from Aug to Oct, and ENSO-neutral conditions returned in Oct 2012.
- Sea level returned to near-normal in the central and eastern equatorial Pacific, consistent to returning to ENSO-neutral conditions.
- Easterly wind anomalies continued to dominate in the central tropical Pacific, unfavorable for El Nino development.

Summary

- Eastern Pacific SST increased rapidly from May to Jul, and El Nino-like conditions presented in Jun-Jul 2012.

- Sea level (SL) was weakly above-normal in the equatorial belt, indicating little coupled growth between SST and SL anomalies.

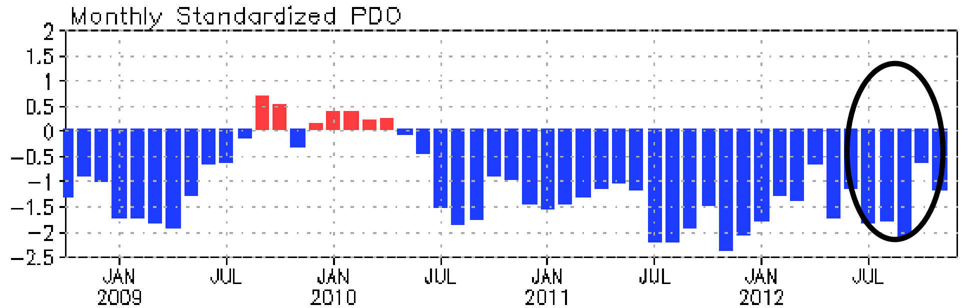
- Easterly wind anomalies dominated in the central tropical Pacific during Jun-Jul, unfavorable for El Nino development.

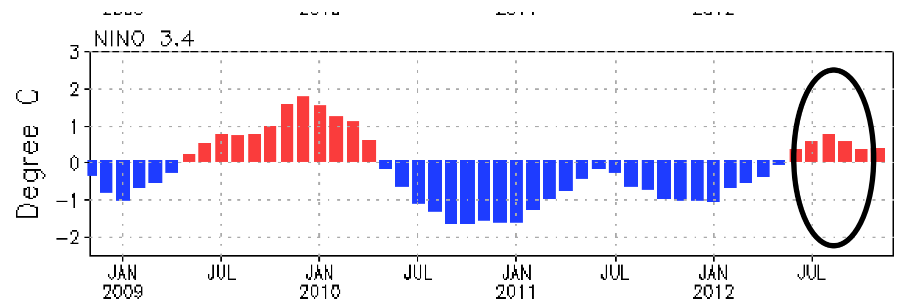
- Positive SSTA dissipated rapidly from Aug to Sep, probably related to upwelling oceanic Kelvin waves, and ENSO-neutral conditions returned in Oct 2012.

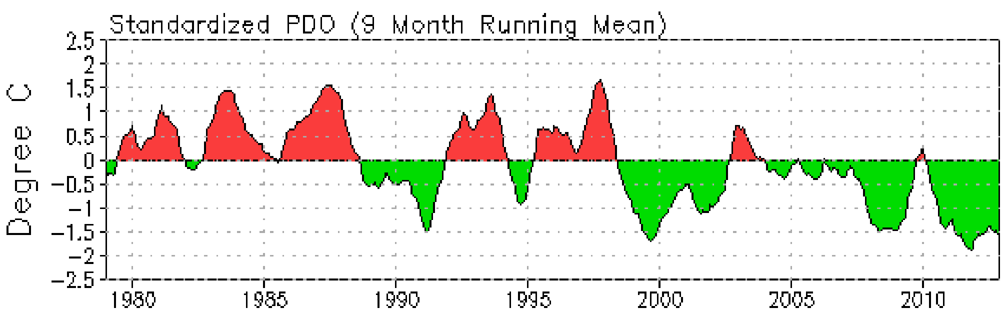
- Most of dynamical models predicted a false alarm El Nino for winter 2012/13 starting from spring and summer initial conditions. The models likely have too strong wind-SST feedback and thermocline feedback, which was actually very weak in the real world.

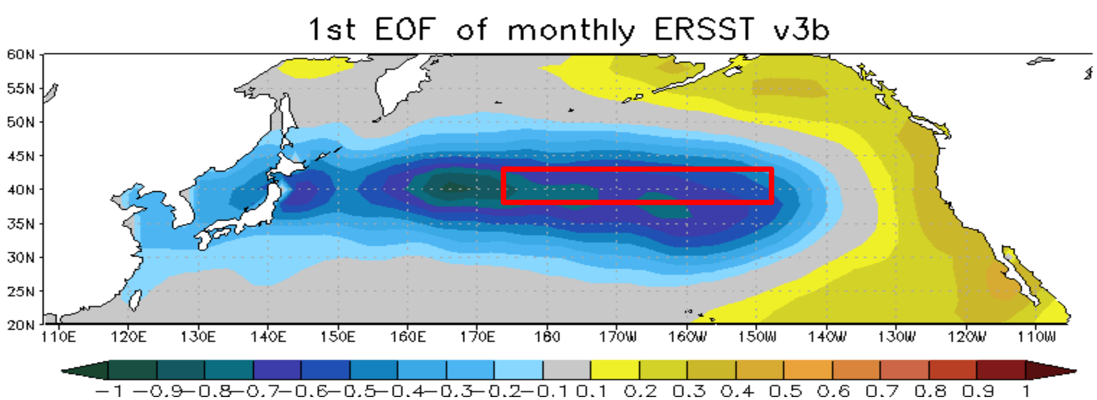
North Pacific & Arctic Oceans

Pacific Decadal Oscillation Index





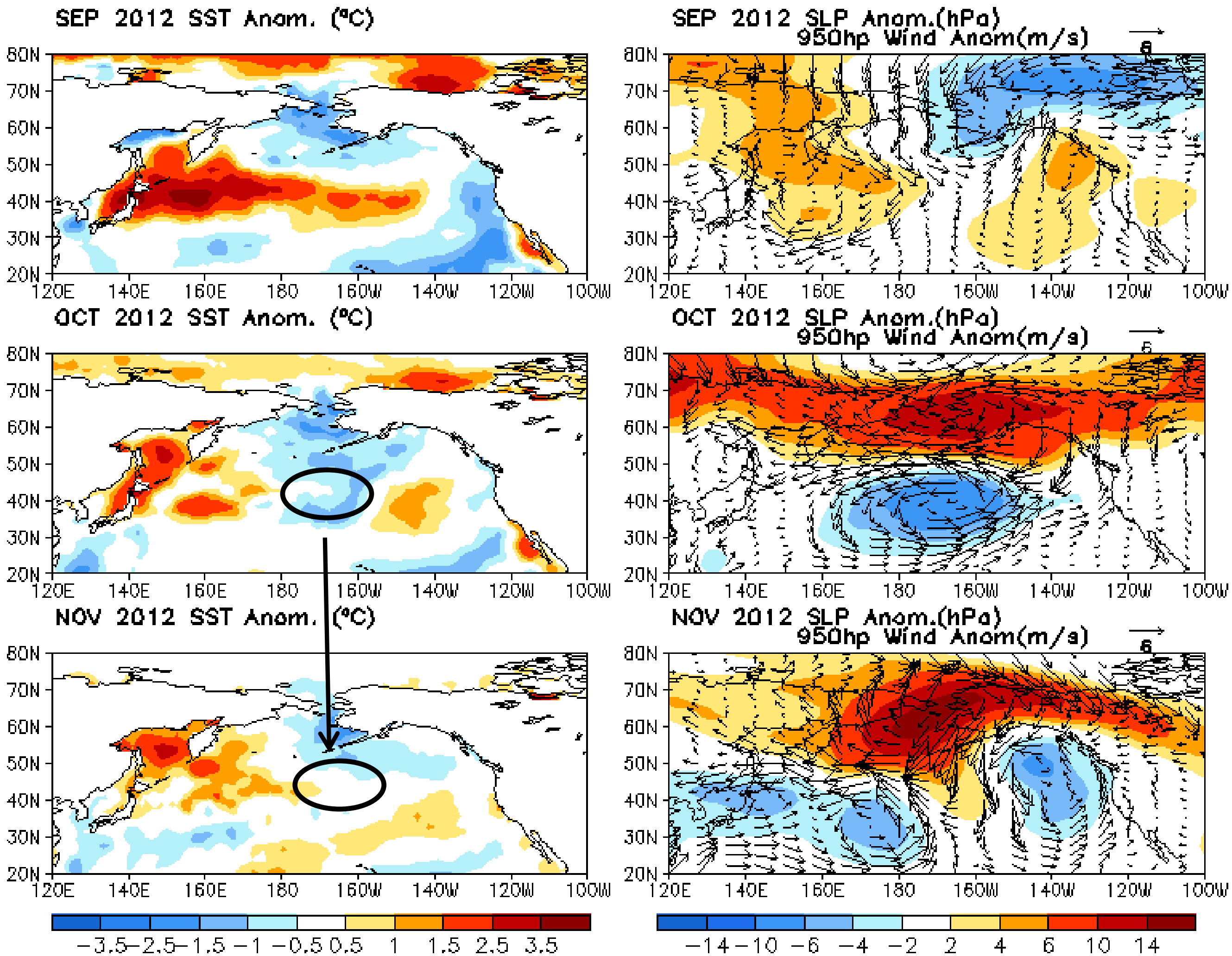




- **Negative PDO phase since May 2010 has persisted for 31 months now, and the PDO index strengthened in Nov 2012 with PDO index = -1.2**
- **The apparent connection between NINO3.4 and PDO index suggest connections between tropics and extratropics.**
- **However, the negative phase of PDO since Jun 2012 seems not connected with the positive Nino3.4 SSTA.**

- **Pacific Decadal Oscillation is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly SST anomalies onto the 1st EOF pattern.**
- **The PDO index differs slightly from that of JISAO, which uses a blend of UKMET and OIv1 and OIv2 SST.**

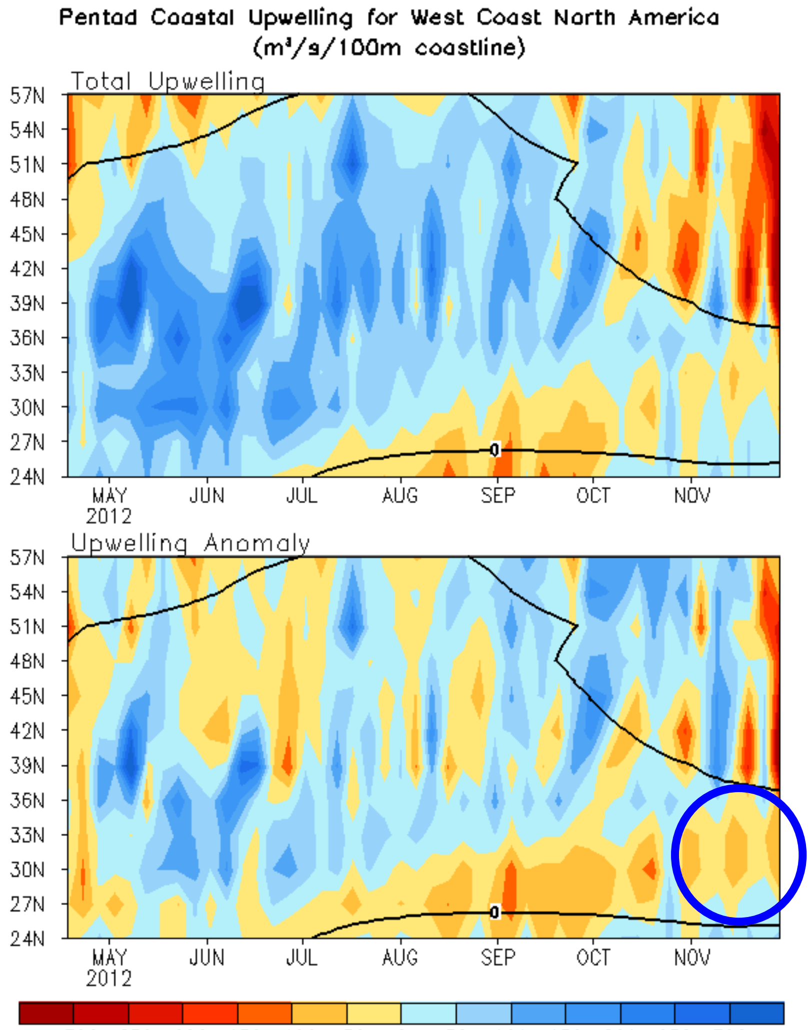
Last Three Month SST, SLP and 925hp Wind Anom.

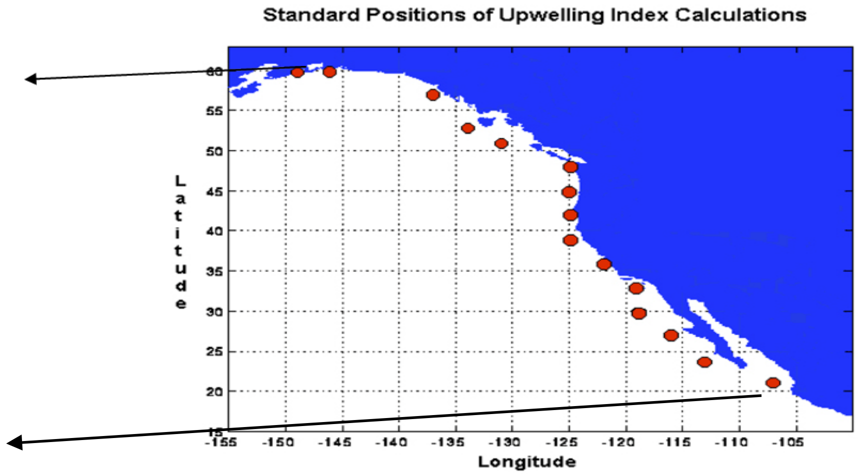


- Negative SSTA in the central N. Pacific dissipated, leading to strengthening of negative PDO-like pattern.

- Anomalous cyclone was observed near the coast of Alaska and Pacific Northwest.

North America Western Coastal Upwelling





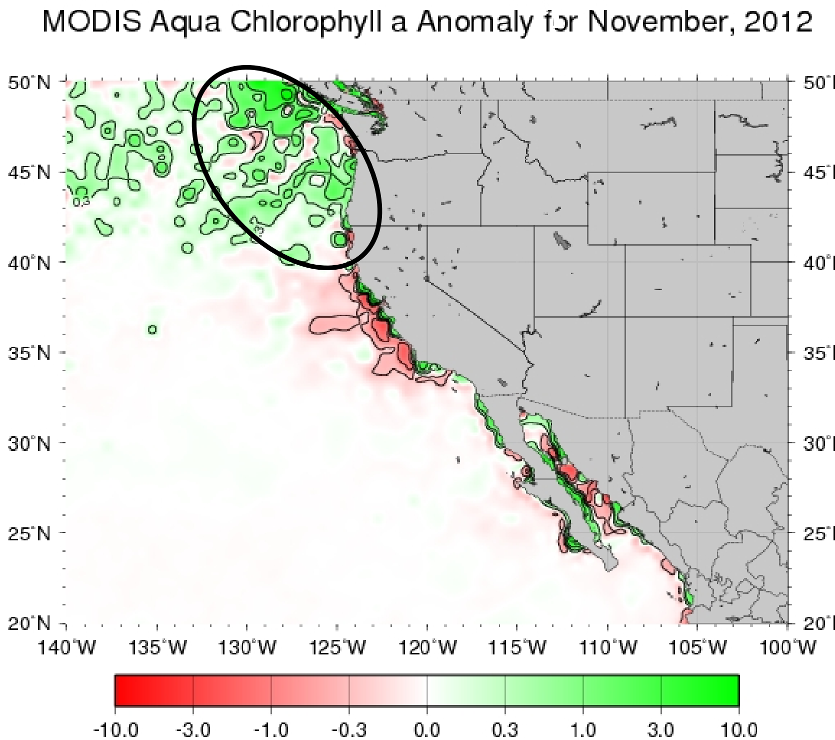
- Upwelling south of 36N was suppressed.

Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport at 50 meter depth from each location to its nearest coast point ($m^3/s/100m$ coastline). Anomalies are departures from the 1981-2010 base period pentad means.

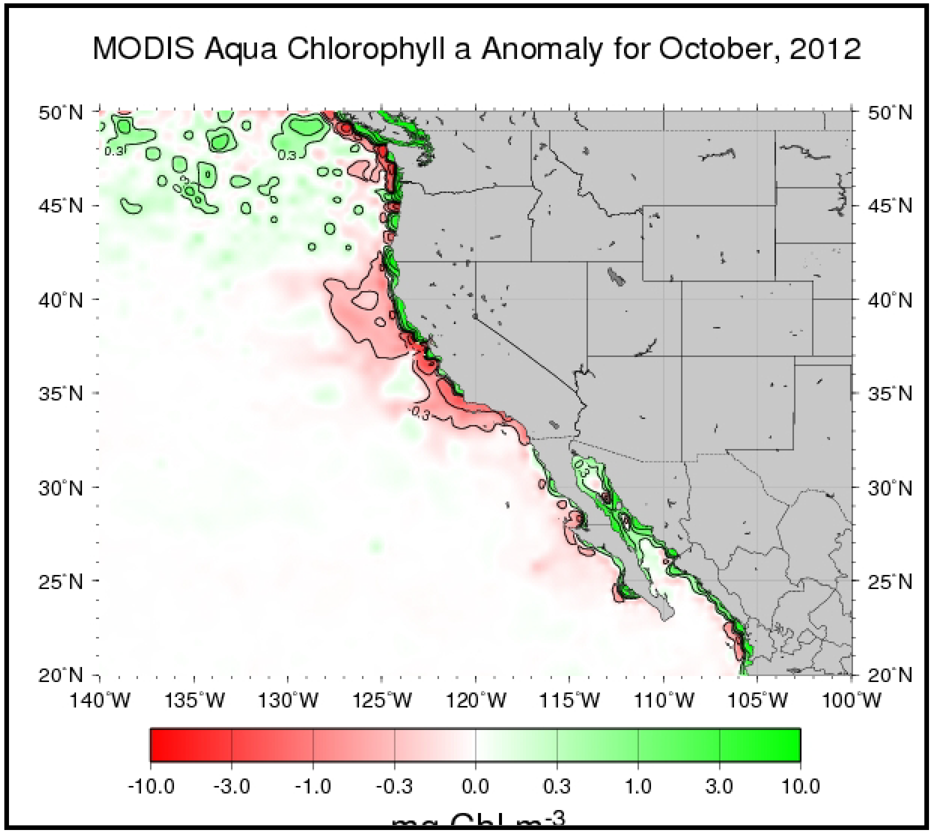
- Area below (above) black line indicates climatological upwelling (downwelling) season.
- Climatologically upwelling season progresses from March to July along the west coast of North America from 36°N to 57°N.

Monthly Chlorophyll Anomaly

http://coastwatch.pfel.noaa.gov/FAST

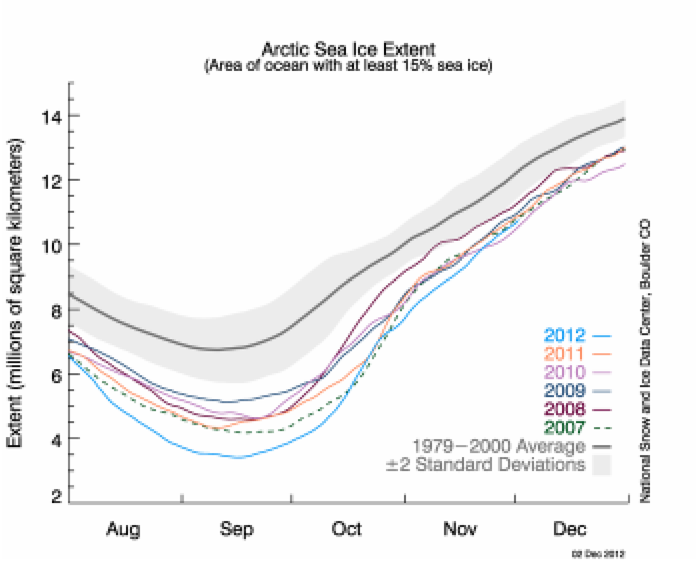


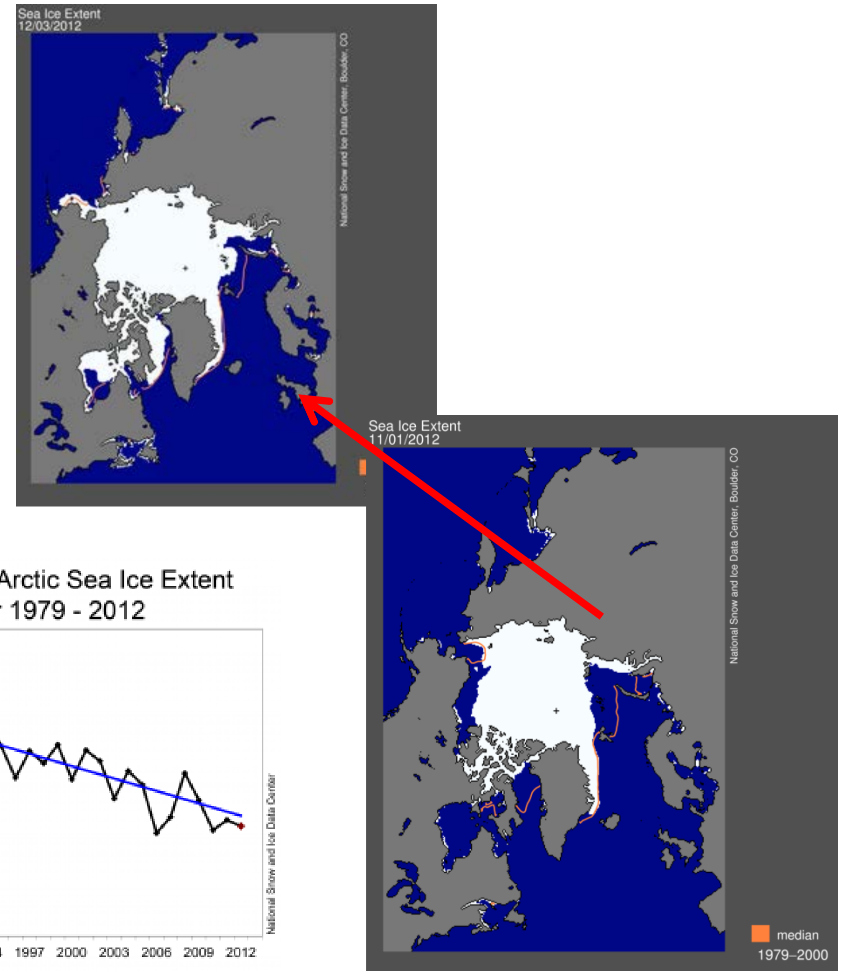
- Positive Chlorophyll anomaly near the coast of Pacific Northwest was associated with anomalous cyclone, which favors Ekman upwelling.

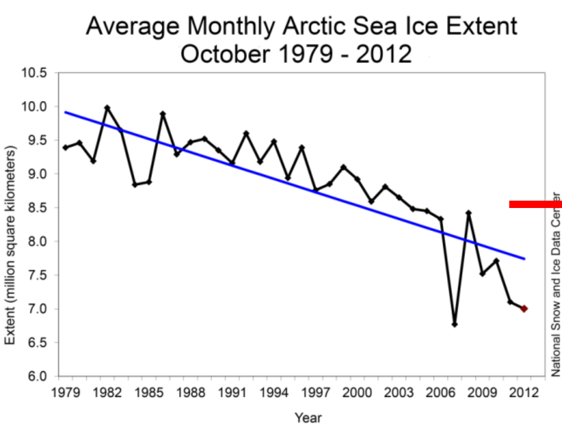


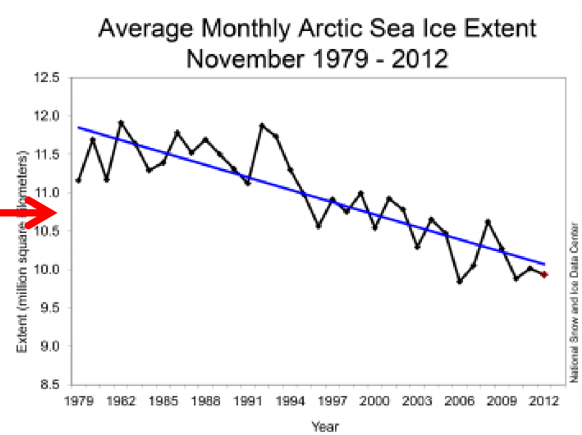
Arctic Sea Ice

http://nsidc.org/arcticseaicenews/index.html.







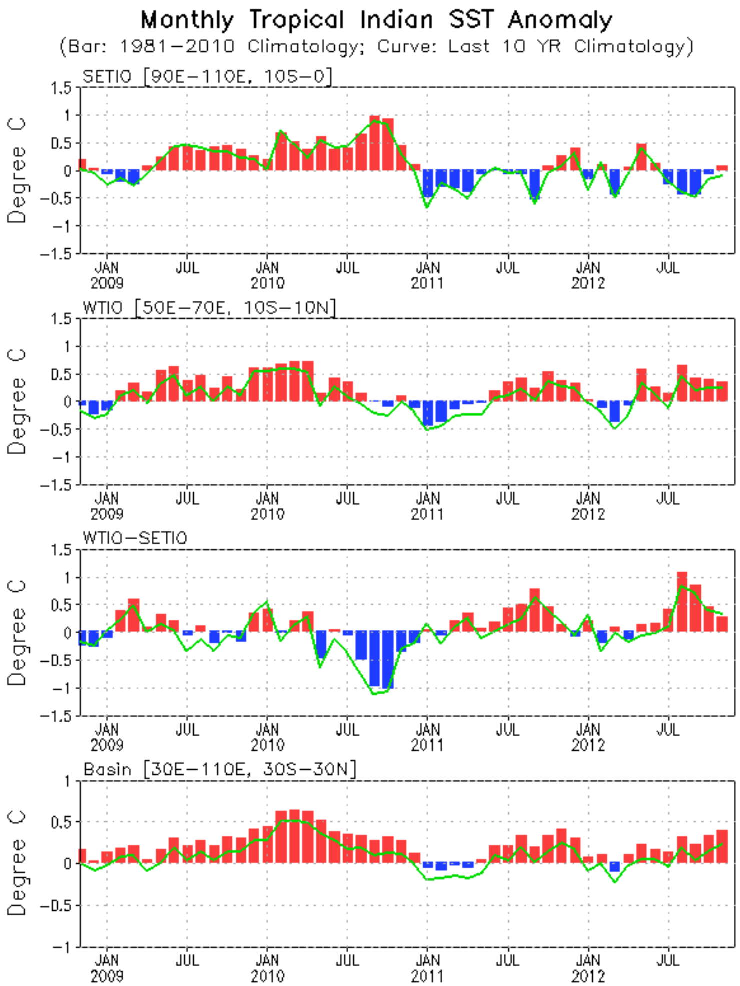


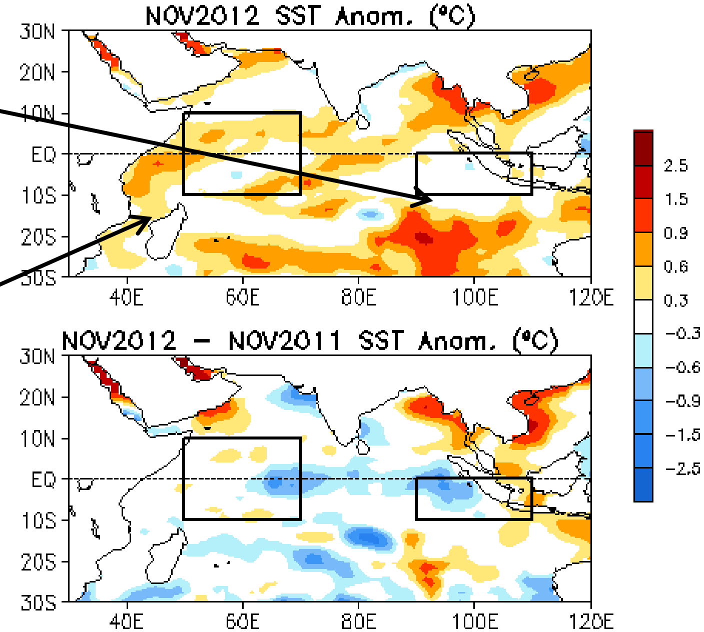
- For the Arctic as a whole, ice growth for November was faster than average.

- Average sea ice extent for November 2012 was the third lowest in the satellite record.

Indian Ocean

Evolution of Indian Ocean SST Indices

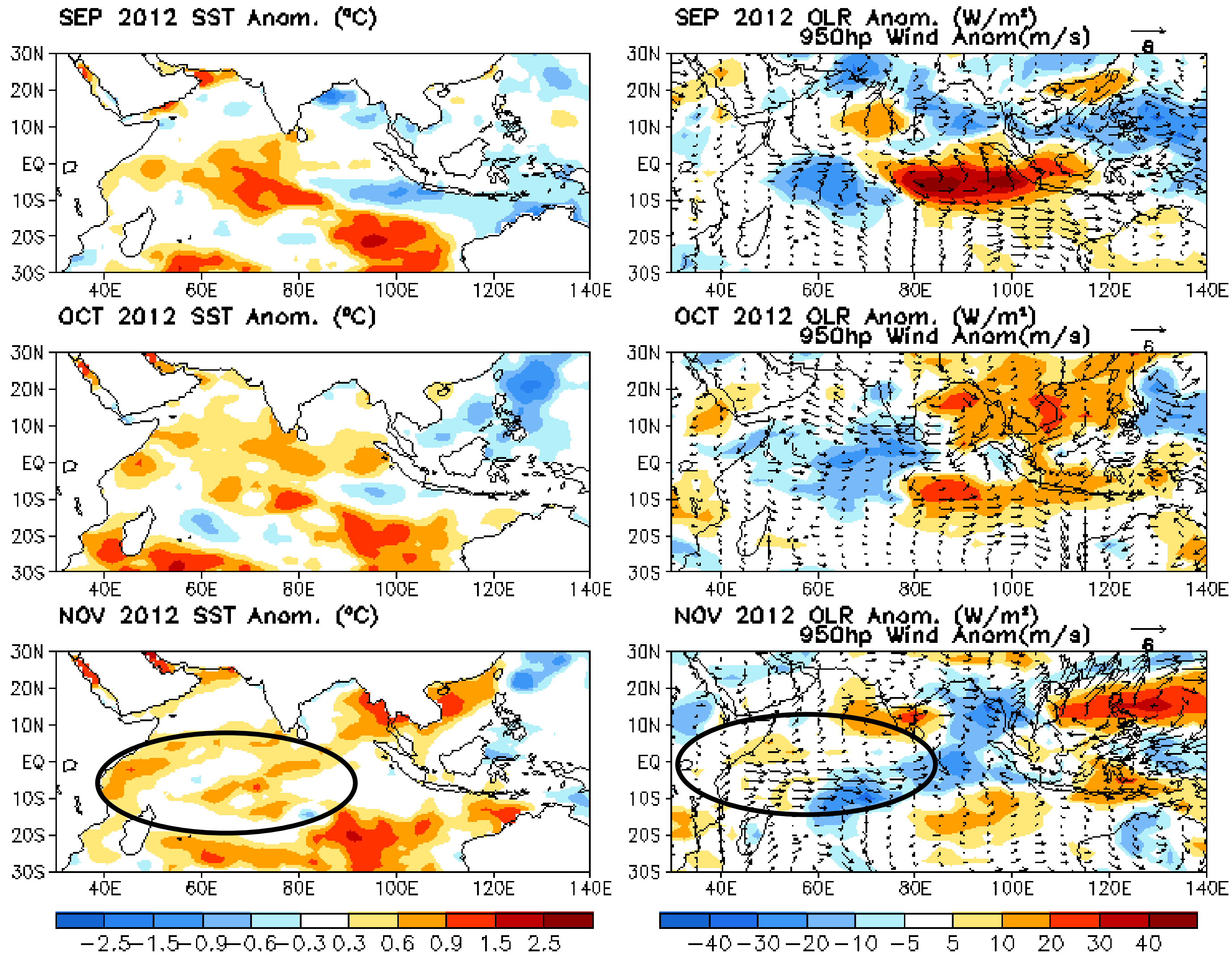




- **DMI was near normal in Nov 2012.**
- **The basin mean SSTA was above-normal.**

Fig. I1a. Indian Ocean Dipole region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (^{O}C) for the SETIO [90°E-110°E, 10°S-0] and WTIO [50°E-70°E, 10°S-10°N] regions, and Dipole Mode Index, defined as differences between WTIO and SETIO. Data are derived from the NCEP OI SST analysis, and departures from the 1981-2010 base period means and the recent 10 year means are shown in bars and green lines.

Last Three Month SST, SLP and 925hp Wind Anom.

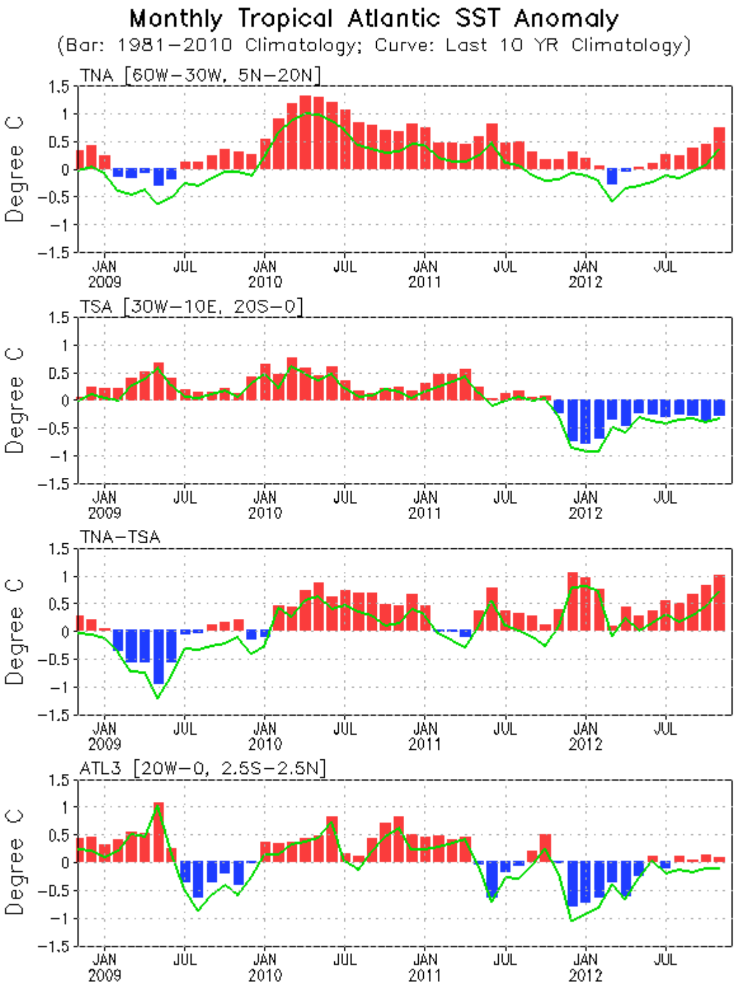


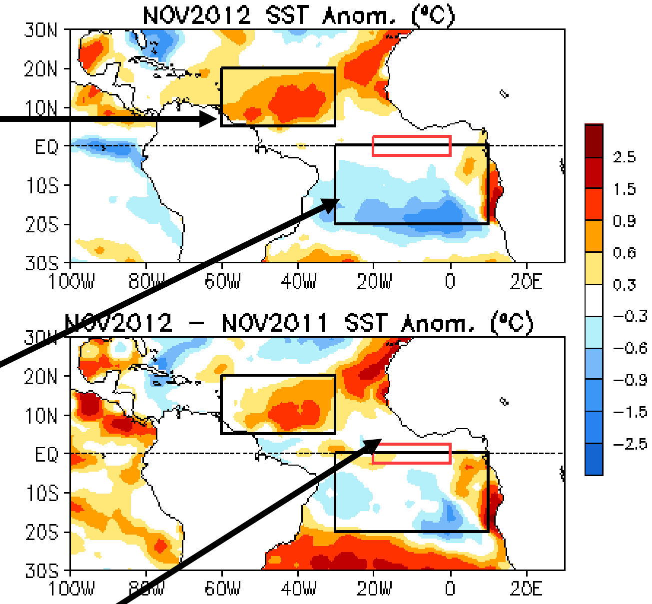
- **Positive SSTA and westerly wind anomalies were observed in the western and central tropical Indian Ocean.**

- **Convection was enhanced (suppressed) in the central tropical Indian Ocean (over Indonesia).**

Tropical and North Atlantic Ocean

Evolution of Tropical Atlantic SST Indices





- SSTA in the tropical North Atlantic (TNA) has increased continuously since Aug 2012, with TNA=0.7°C in Nov 2012.

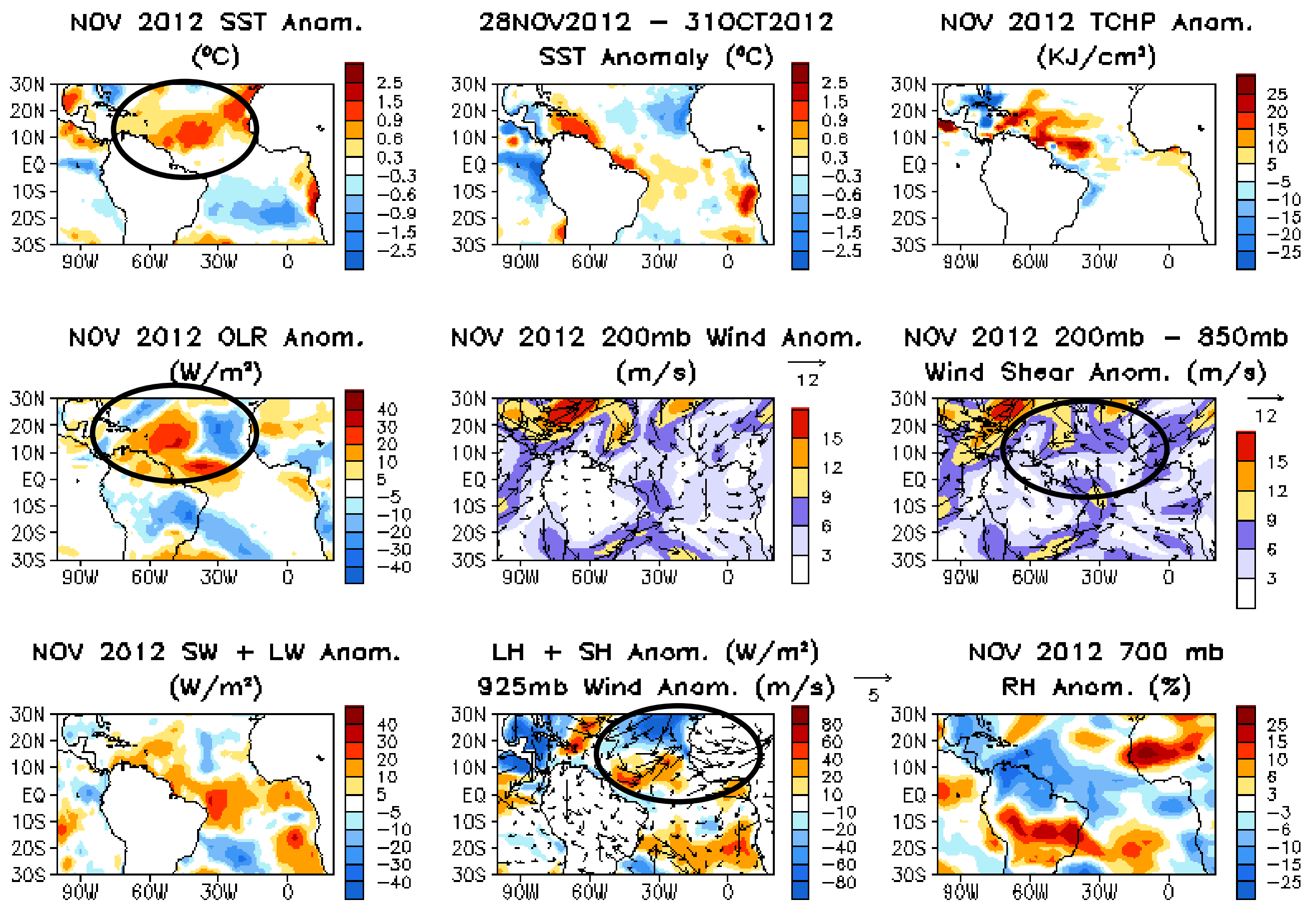
- Meridional Gradient Mode index (TNA-TSA) also increased continuously since Aug 2012.

- ATL3 SSTA was near-normal since Jun 2012.

Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the TNA [60°W-30°W, 5°N-20°N], TSA [30°W-10°E, 20°S-0] and ATL3 [20°W-0, 2.5°S-2.5°N] regions, and Meridional Gradient Index, defined as differences between TNA and TSA. Data are derived from the NCEP OI SST analysis, and departures from the 1981-2010 base period means and the recent 10 year means are shown in bars and green lines.

Tropical Atlantic:

SST Anom., SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, 925-mb/200-mb Winds



- Above-normal SSTA persisted in the hurricane Main Development Region (MDR) .
- Below-normal vertical wind shear presented in MDR.
- Convection was suppressed (enhanced) in the western (eastern) tropical North Atlantic.
- Westerly low-level wind blew towards the western Africa, indicating enhanced west African monsoon.

2012 Atlantic Hurricane Season

http://www.cpc.ncep.noaa.gov/products/outlooks/hurricane.shtml

http://www.nhc.noaa.gov/text/MIATWSAT.shtml

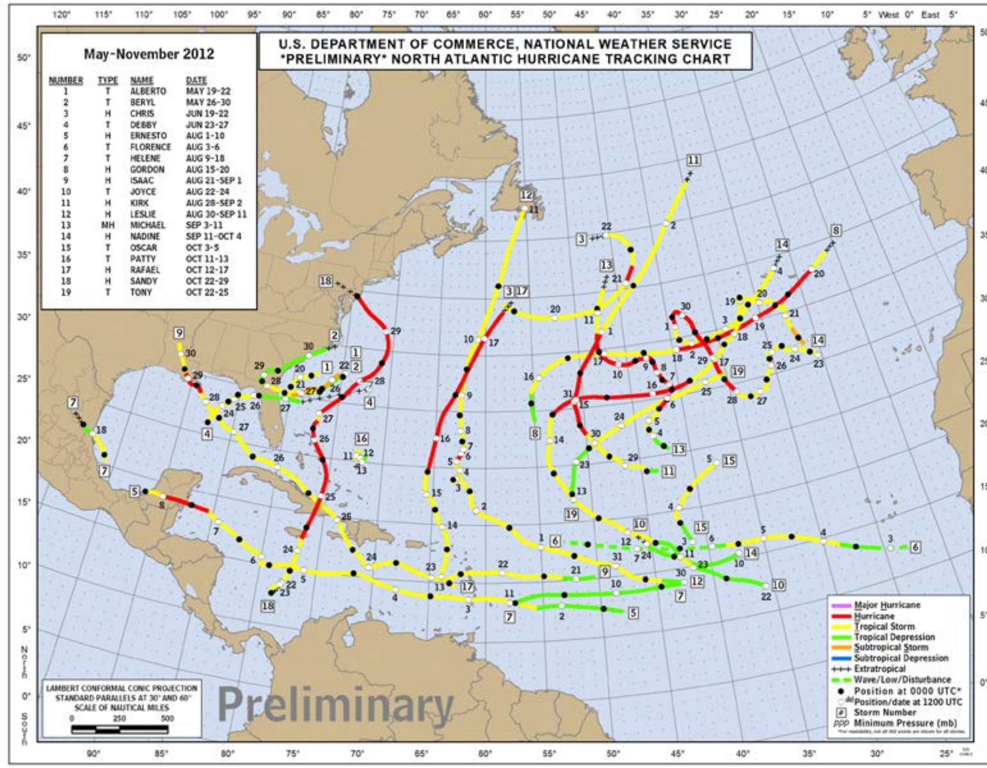
NOAA 2012 Atlantic Hurricane Season Outlooks

Activity Type	August Update	May 19 Outlook	NHC 1981-2010 Normals
Chance Above Normal	35%	25%	
Chance Near Normal	50%	50%	
Chance Below Normal	15%	25%	
Named Storms*	12-17	9-15	12
Hurricanes*	5-8	4-8	6
Major Hurricanes	2-3	1-3	3
ACE (% Median)	75-135	65-140	71-111**

The outlooks indicate a 70% probability for each range of activity.

* Includes all such storms regardless of strength

**A near-normal season has ACE values of 71%-111% of the median.

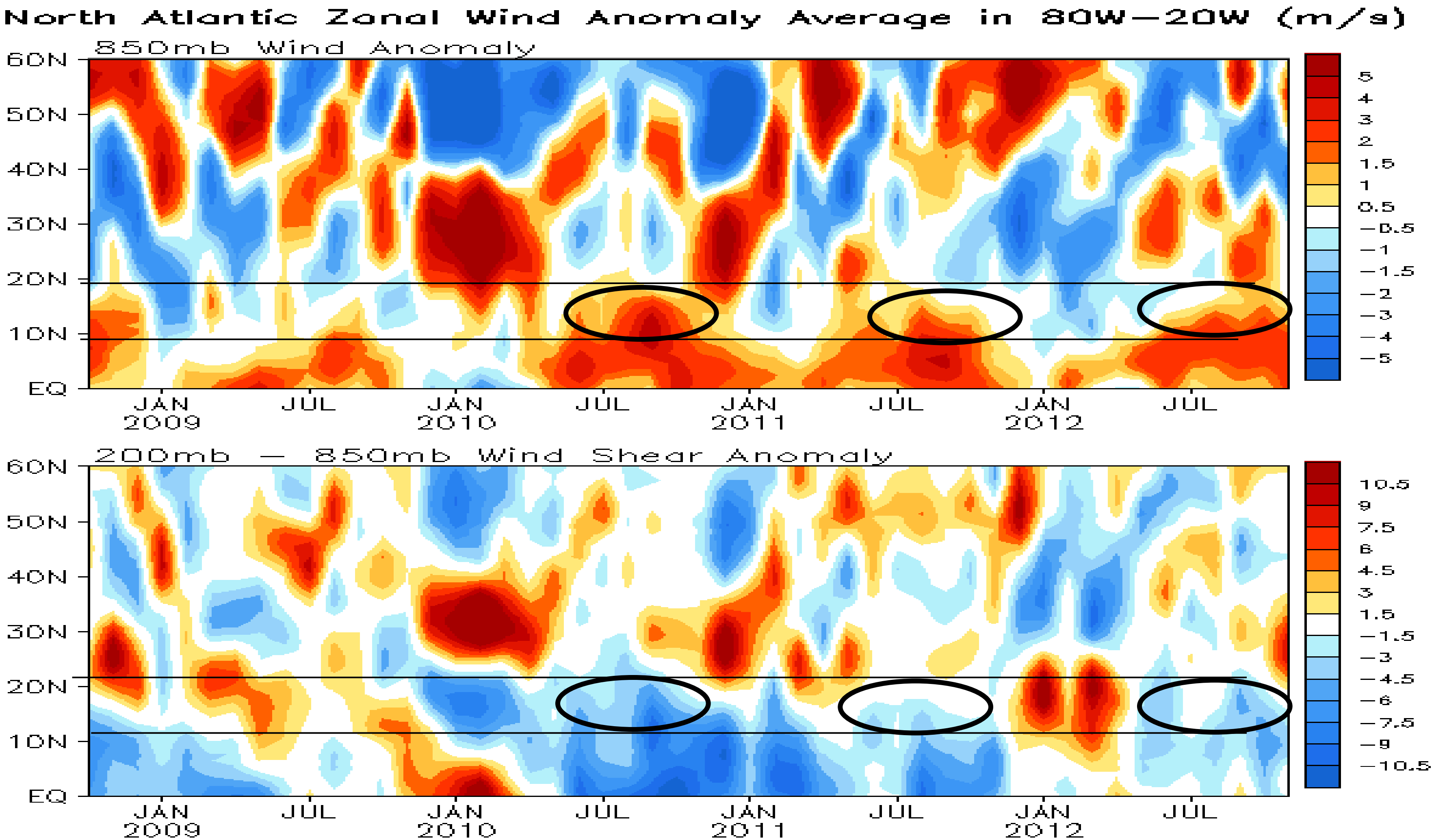


- **NOAA 2012 Atlantic Hurricane Outlook issued in August called for 12-17 tropical storms (TS), 5-8 hurricanes (H) and 2-3 major hurricanes (MH).**

- **Activity for 2012 (19 TSs, 10 Hs and 1 MHs) was well above the average (12 TSs, 6 Hs and 3 MHs) for TSs and Hs, and below average for MHs.**

- **In terms of accumulated cyclone energy, which measures the combined strength and duration of tropical storms and hurricanes, tropical cyclone activity in the Atlantic basin during 2012 was about 140% of the 1981-2010 median, which largely agrees with NOAA ACE Outlook(75-135%).**

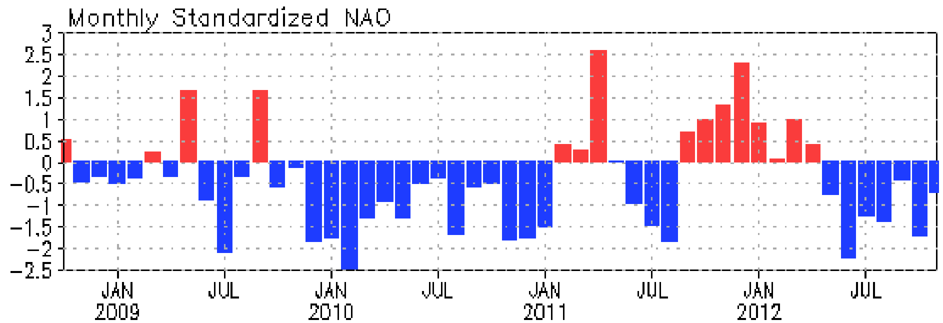
North Atlantic U850 and U200-U850

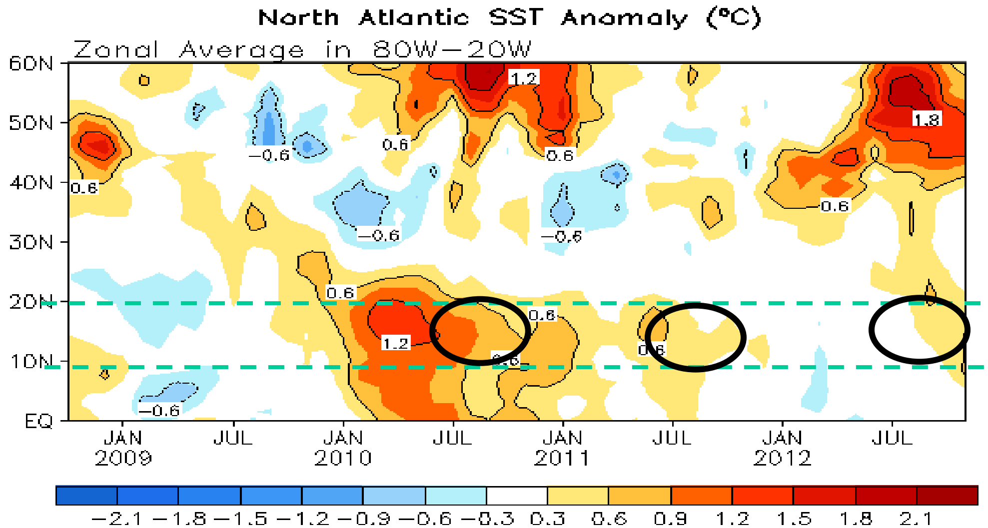


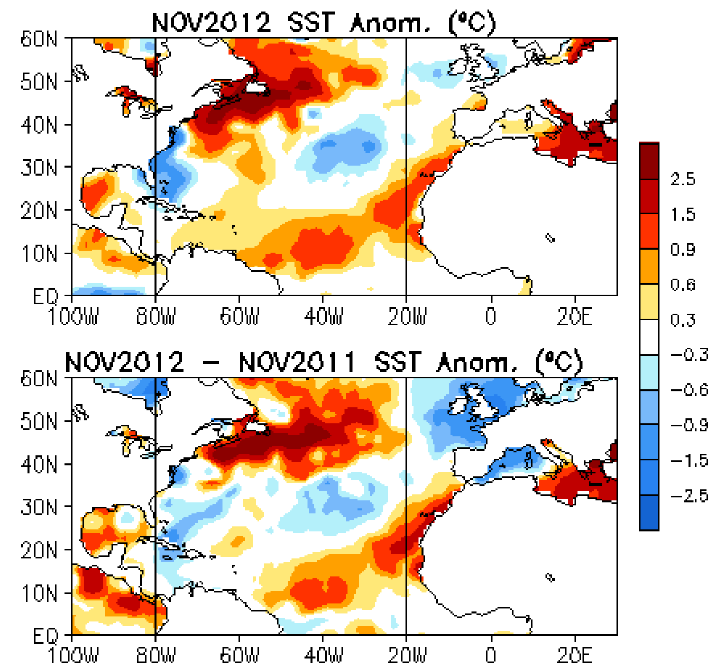
- In the Hurricane Main Development Region (80W-20W, 10N-20N), westerly wind anomalies near the surface and below-normal vertical wind shear were observed in JJASON 2012, which is favorable for hurricane development.

- The anomalies in JJASON 2012 were weaker than (similar to) those in JJASON 2010 (2011).

NAO and SST Anomaly in North Atlantic







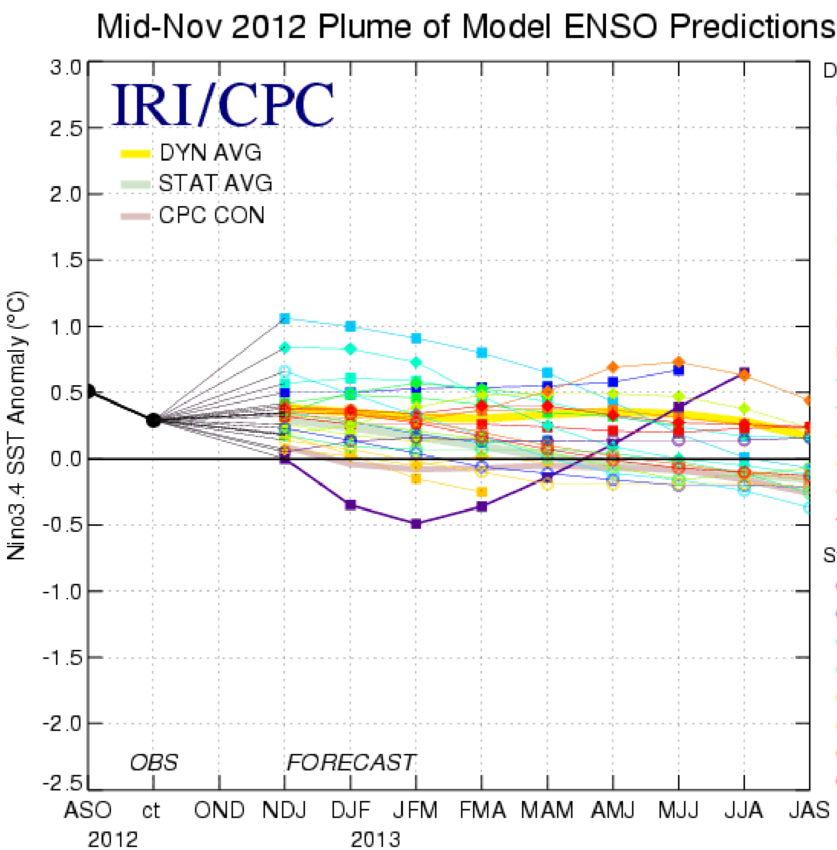
- High-latitude North Atlantic SSTA is generally closely related to NAO index (negative NAO leads to SST warming and positive NAO leads to SST cooling). Negative NAO index has persisted for 7 months, contributing to persistent positive SSTA in high-latitude N. Atlantic, and also a warming in tropical N. Atlantic in Nov 2012.

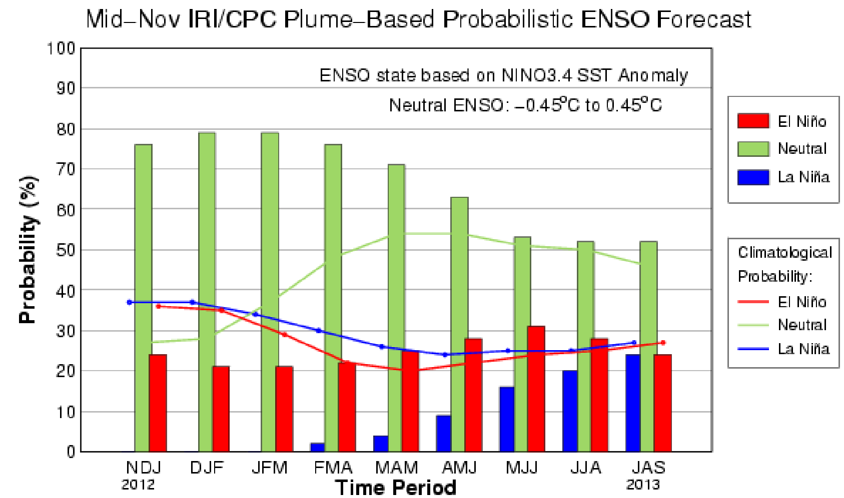
- In the past three hurricane seasons, positive SSTA in MDR was strong in 2010, and became weakening in subsequent two years.

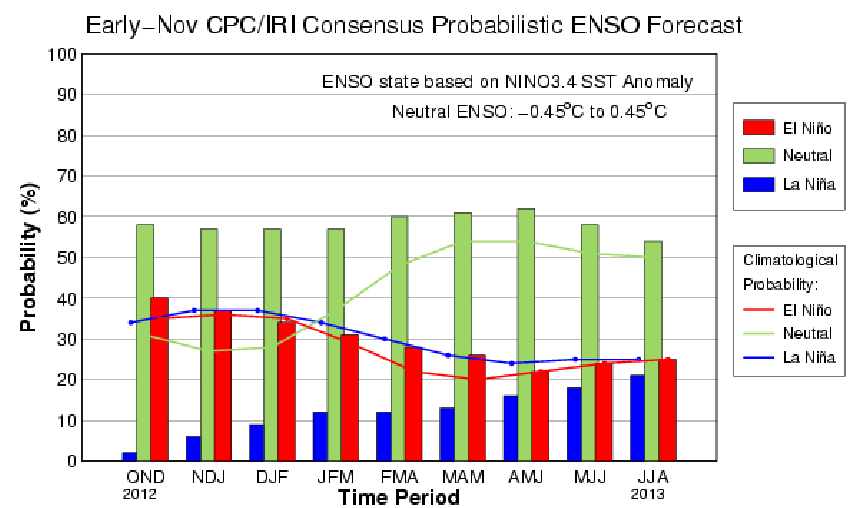
Fig. NA2. Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20°N-90°N (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80°W and 20°W (bottom). SST are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

Global SST Predictions

IRI / CPC NINO3.4 Forecast Plume



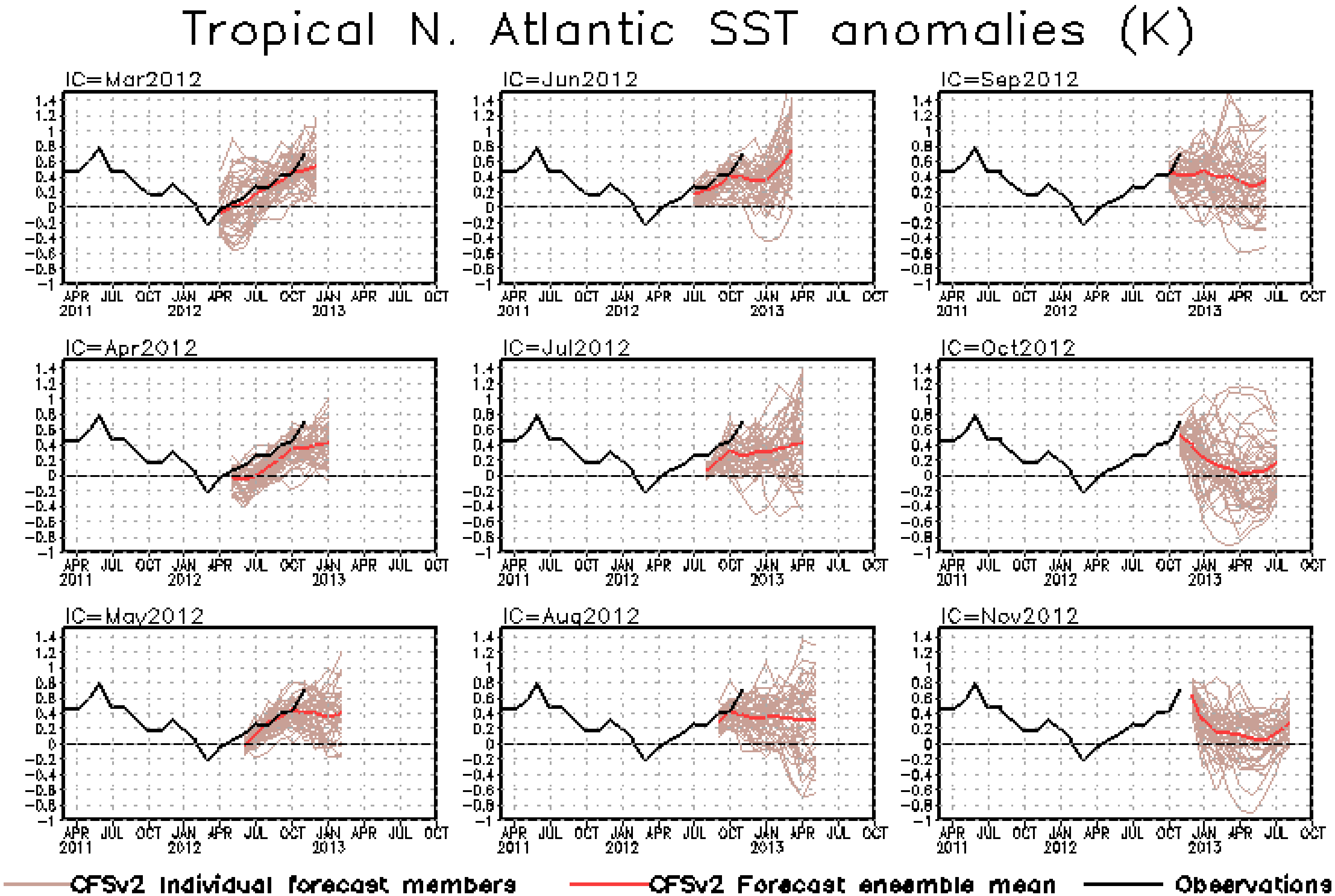




- **Most of the models predicted ENSO-neutral in the coming Northern Hemisphere winter and spring.**
- **The consensus forecast favors ENSO-neutral conditions in the winter and next spring.**

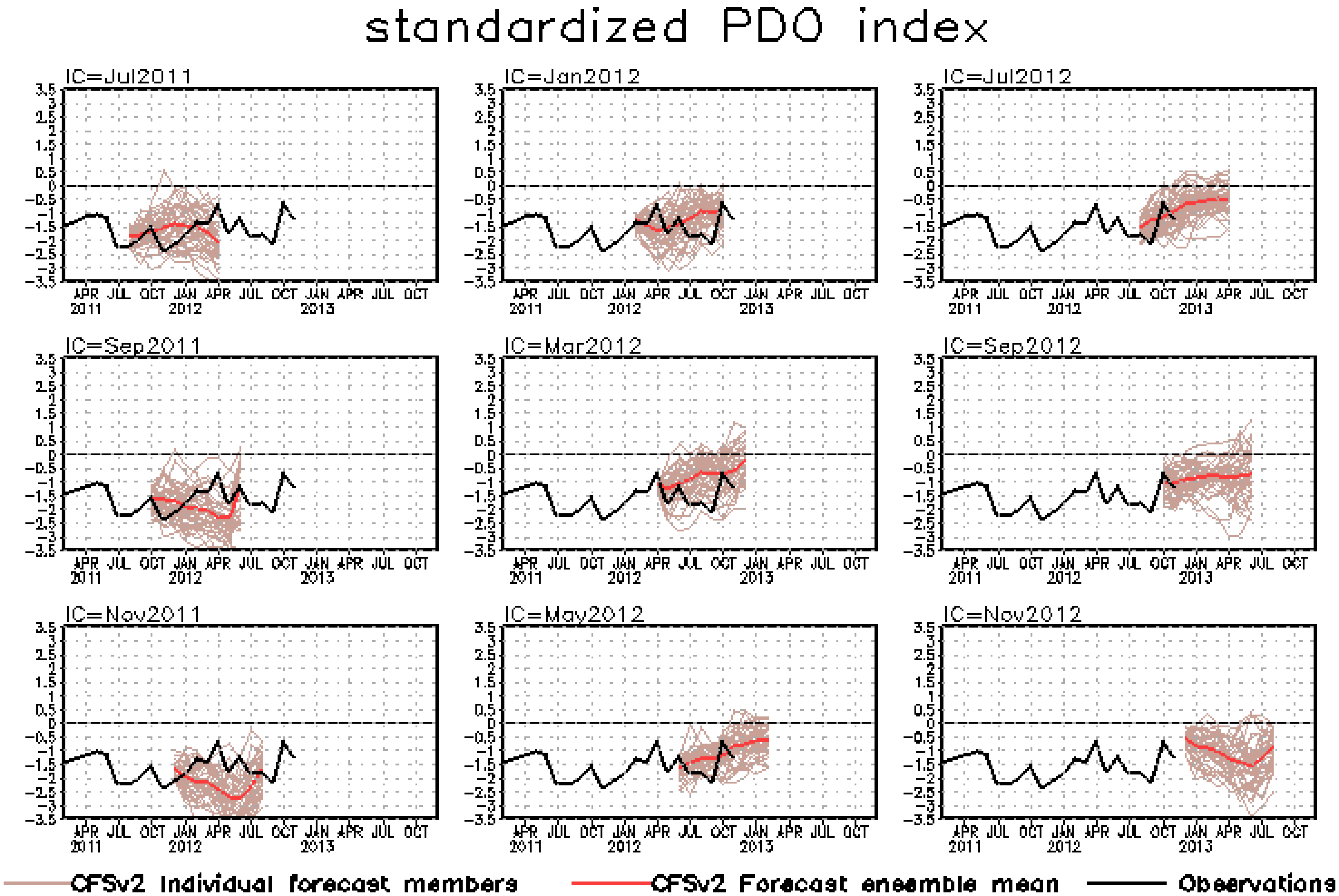
NCEP CFSv2 Tropical North Atlantic SST Forecast

CFSv1 was discontinued in September 2012



- Latest CFSv2 prediction suggests tropical North Atlantic SST will cool down and return to normal-conditions in late winter and next spring.
- The CFSv2 predicted the warming tendency quite well from Jan-Mar I.C..

NCEP CFSv2 Pacific Decadal Oscillation (PDO) Forecast



PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110°E-100°W, 20°N-60°N].

CFS PDO index is the standardized projection of CFS SST forecast anomalies onto the PDO EOF pattern.

- Latest CFSv2 prediction suggests weak negative PDO phase will persist through the coming winter and regain strength in next spring and summer.

Summary

- ## Pacific and Arctic Oceans

- ENSO-neutral conditions continued during Nov 2012.
- The consensus forecast favors ENSO-neutral conditions to continue into the Northern Hemisphere winter 2012/13 and spring 2013.
- Negative PDO phase strengthened with PDO=-1.2 in Nov 2012, and NCEP CFSv2 predicted negative PDO phase would continue into next spring.
- For the Arctic as a whole, ice growth in November was faster than average.

- ## Indian Ocean

- Indian Ocean Dipole was near-normal in Nov 2012.

- ## Atlantic Ocean

- Negative NAO phase weakened with NAO=-0.74 in Nov 2012. The persistent negative NAO phase in the past 7 months contributed to a strong warming in high-latitude N. Atlantic.
- 2012 Atlantic hurricane season has 19 tropical storms (TSs), 10 hurricanes (Hs) and 1 major hurricanes (MHs), which is well above the average for TSs and Hs and below average for MHs.
- In terms of accumulated cyclone energy (ACE), tropical cyclone activity in the Atlantic basin during 2012 was about 140% of the 1981-2010 median, which largely agrees with the NOAA ACE Outlook (75-135%).

Backup Slides

Tropical Pacific: SST Anom., SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Winds

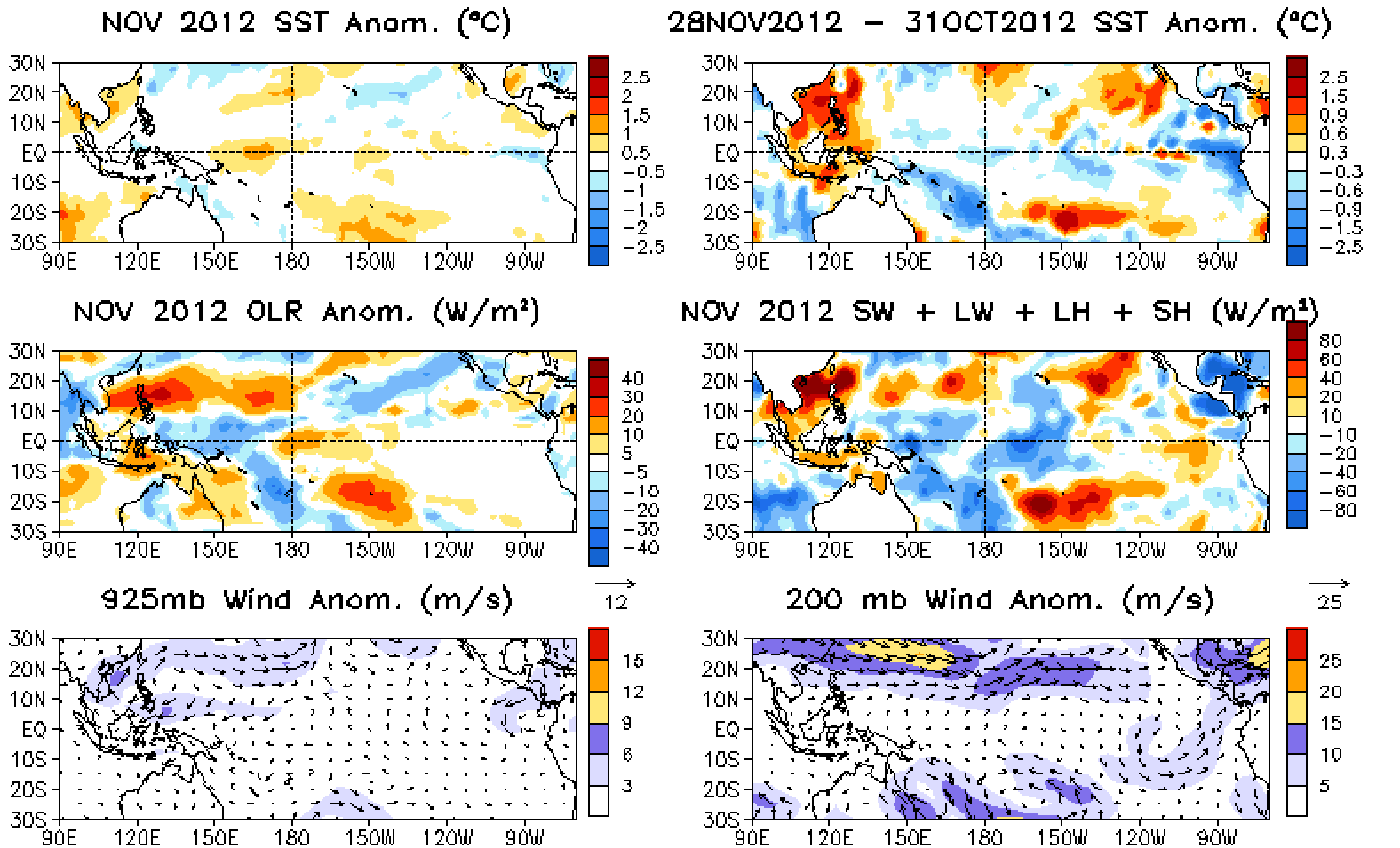


Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, winds and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1981-2010 base period means.

North Pacific & Arctic Ocean: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Fl

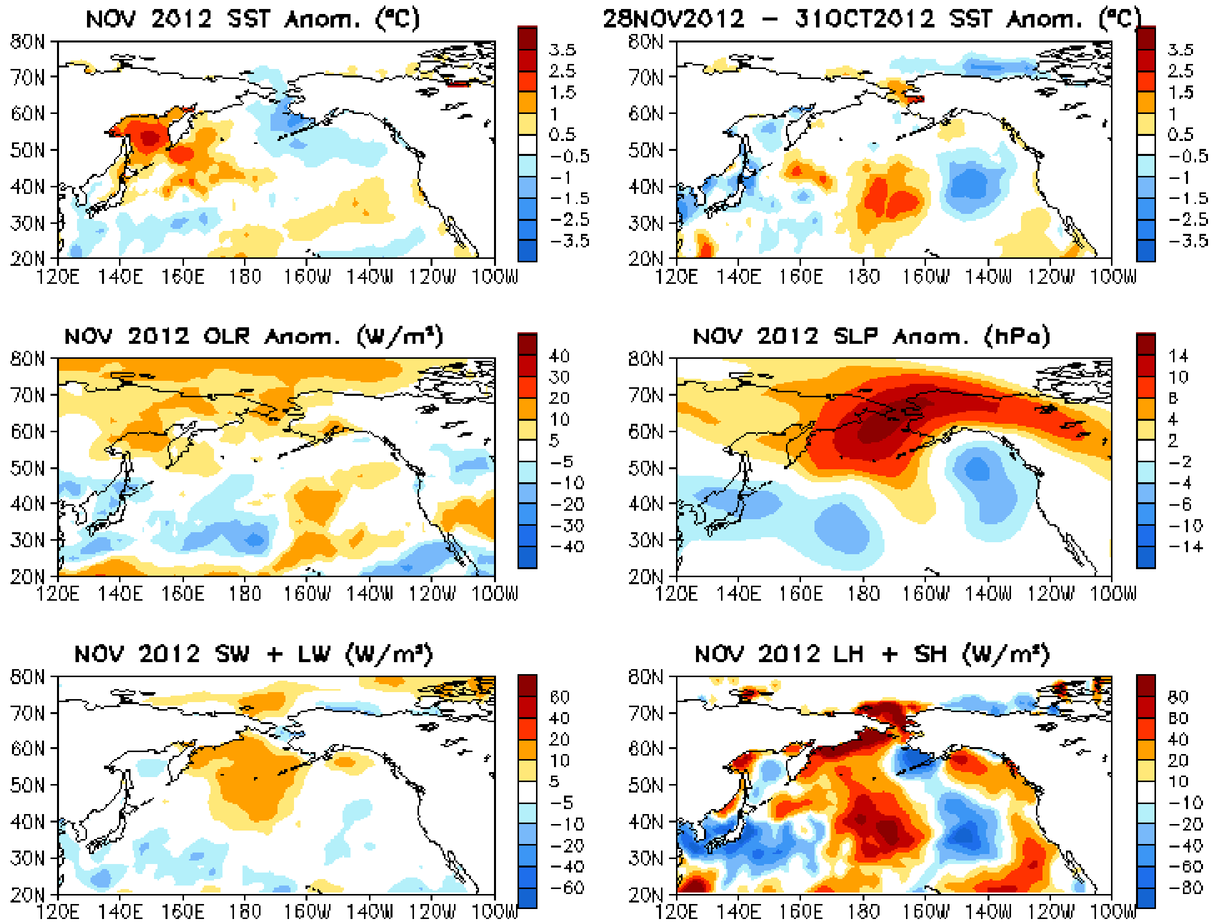
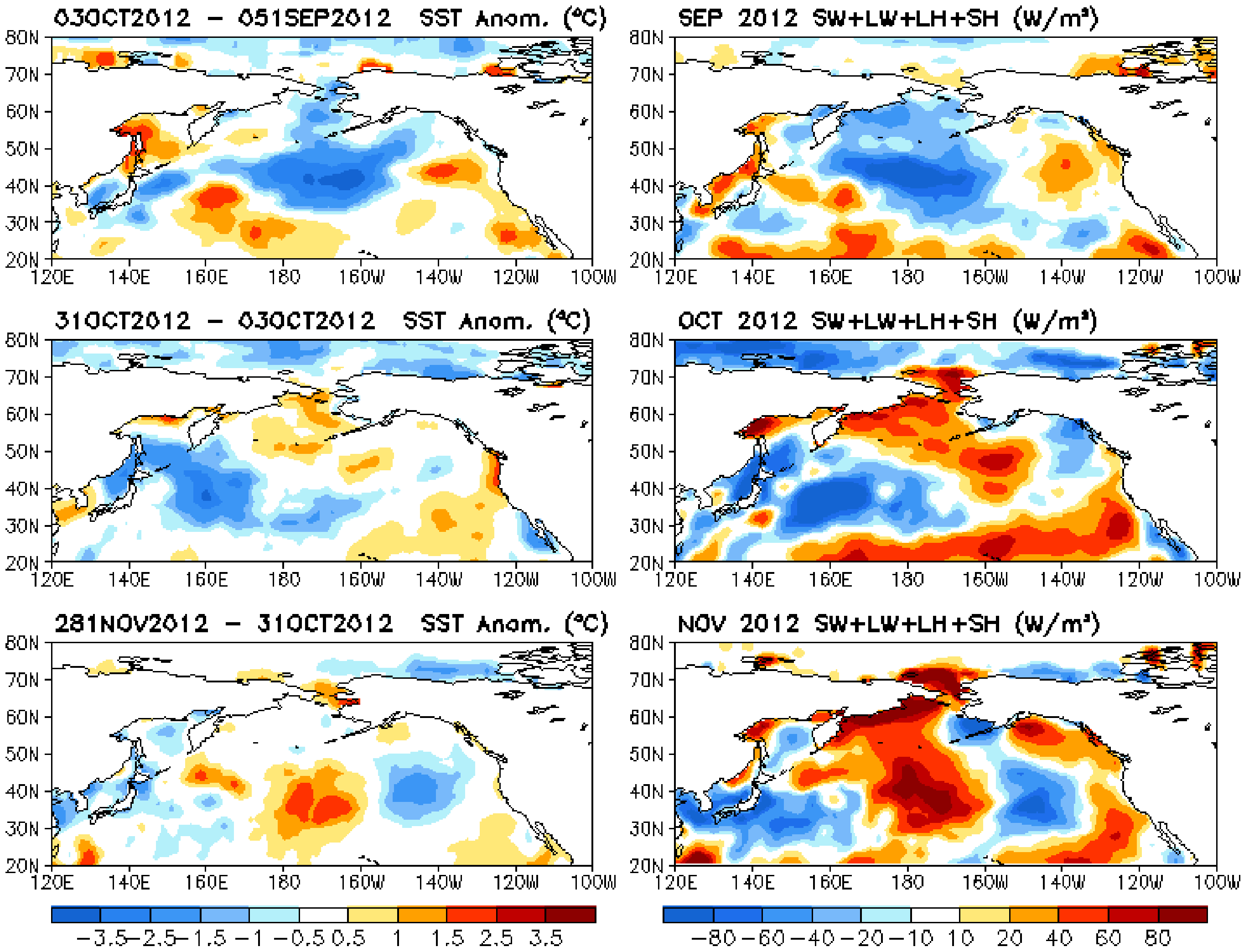


Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible heat flux anomalies (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, sea surface pressure and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1981-2010 base period means.

Last Three Month SST Tendency and Surface Heat flux Anom.



- SSTA tendency were generally consistent with surface heat flux anomalies, suggesting the importance of atmosphere forcing.

Tropical Indian: SST Anom., SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Wind Anom.

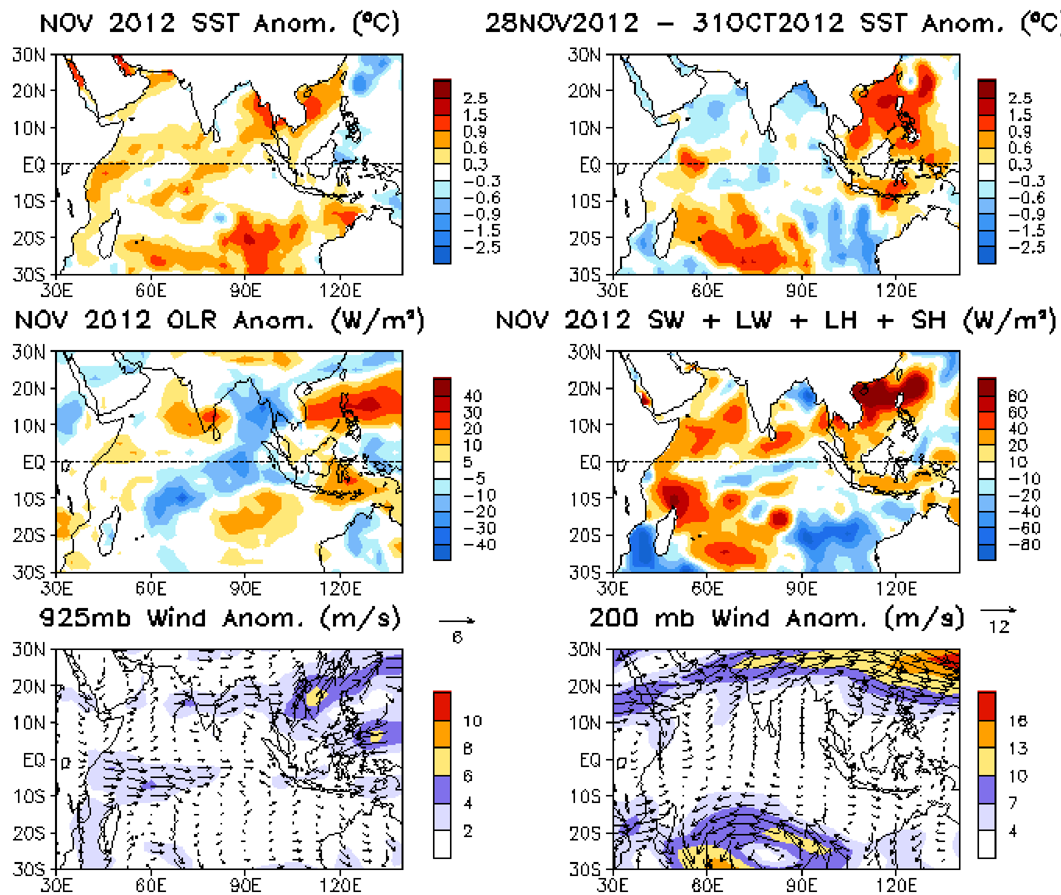


Fig. 12. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, winds and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1981-2010 base period means.

North Atlantic: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

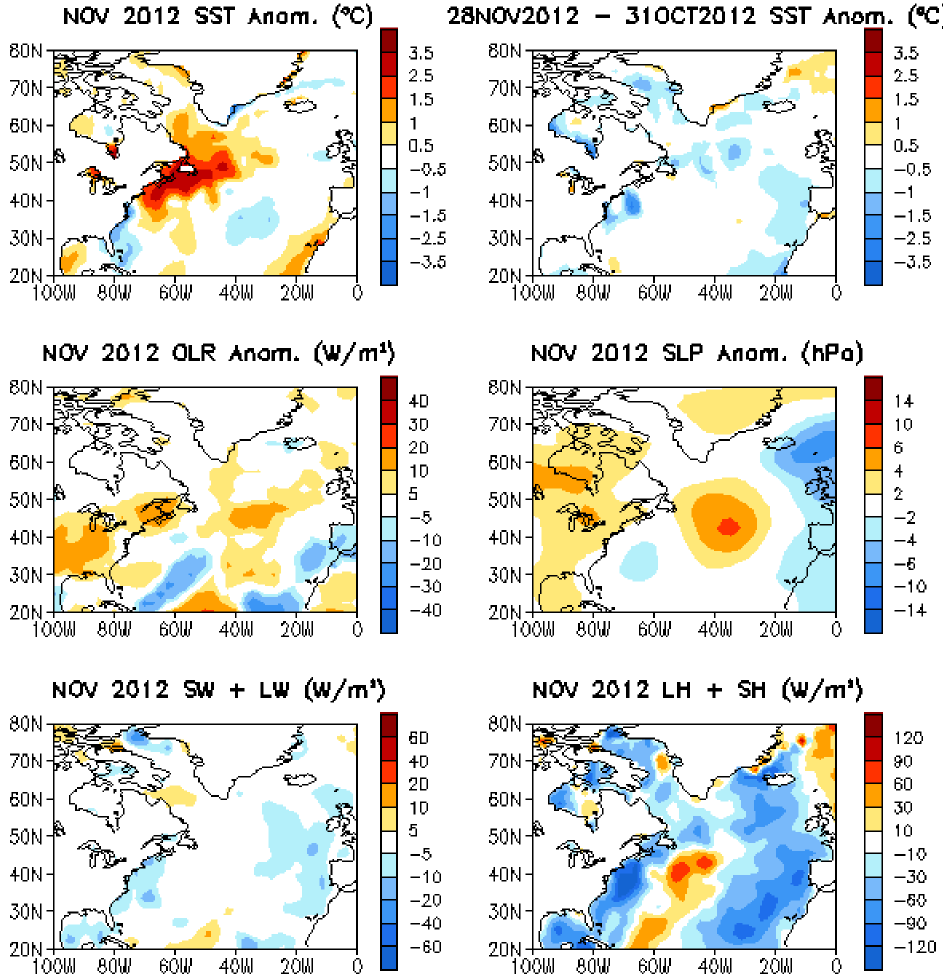
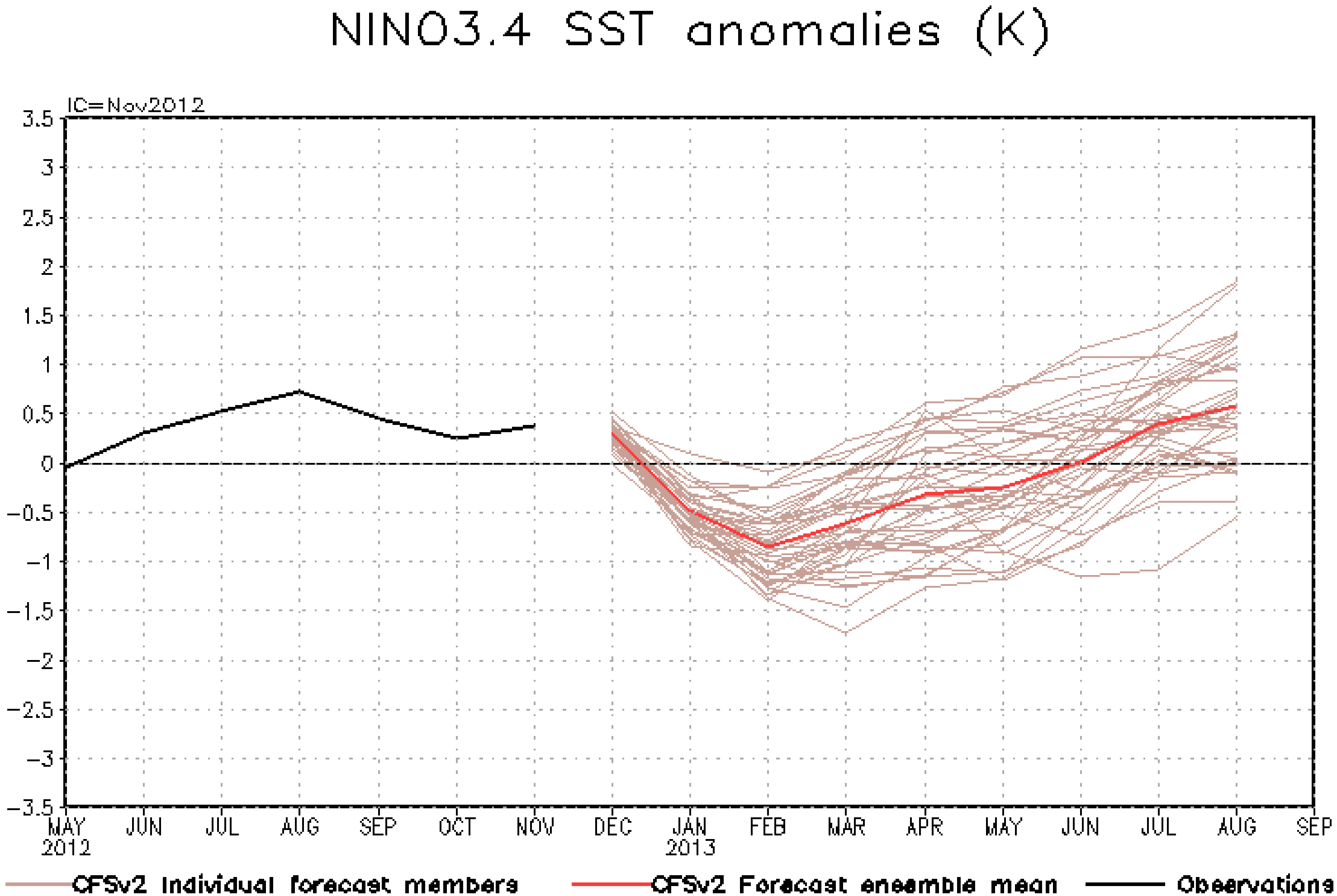
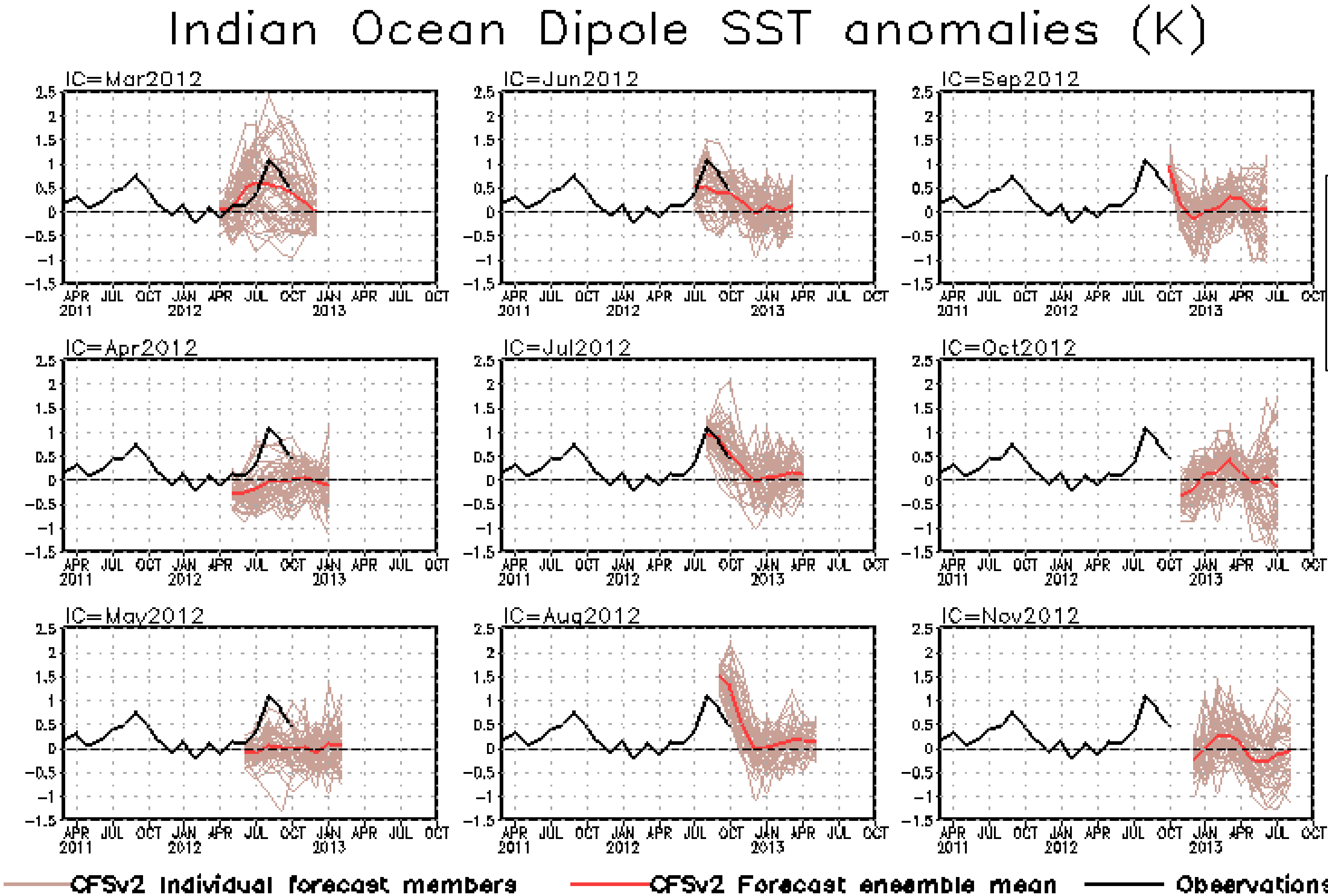


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible heat flux anomalies (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, sea surface pressure and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1979-1995 base period means except SST anomalies are computed with respect to the 1971-2000 base period means.


NINO3.4 SST anomalies (K)
IC=Nov2012
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
−3
−3.5
MAY 2012
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN 2013
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
CFSv2 individual forecast members
CFSv2 Forecast ensemble mean
Observations

NCEP CFS DMI SST Predictions from Different Initial Months



DMI = WTIO- SETIO

SETIO = SST anomaly in [90ºE-110ºE, 10ºS-0]

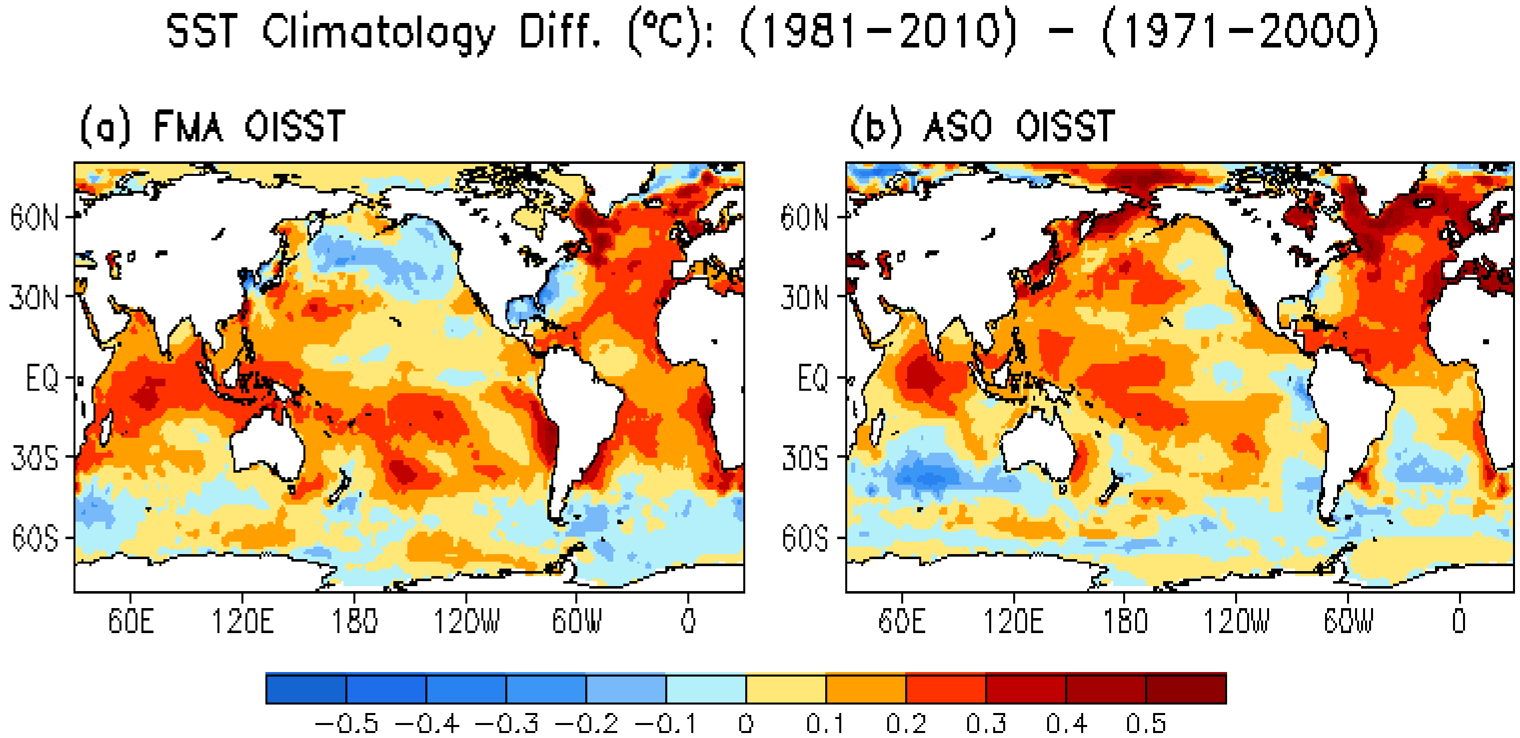
WTIO = SST anomaly in [50ºE-70ºE, 10ºS-10ºN]

Fig. M2. CFS Dipole Model Index (DMI) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). The hindcast climatology for 1981-2006 was removed, and replaced by corresponding observation climatology for the same period. Anomalies were computed with respect to the 1981-2010 base period means.

Switch to 1981-2010 Climatology

- **SST from 1971-2000 to 1981-2010**
  - **Weekly OISST.v2, monthly ERSST.3b**
- **Atmospheric fields from 1979-1995 to 1981-2010**
  - **NCEP CDAS winds, sea level pressure, 200mb velocity potential, surface shortwave and longwave radiation, surface latent and sensible fluxes, relative humidity**
  - **Outgoing Long-wave Radiation**
- **Oceanic fields from 1982-2004 to 1981-2010**
  - **GODAS temperature, heat content, depth of 20°C, sea surface height, mixed layer depth, tropical cyclone heat potential, surface currents, upwelling**
- **Satellite data climatology 1993-2005 unchanged**
  - **Aviso Altimetry Sea Surface Height**
  - **Ocean Surface Current Analyses – Realtime (OSCAR)**

Be aware that new climatology (1981-2010) was applied since Jan 2011



1971-2000 SST Climatology (Xue et al. 2003):
http://www.cpc.ncep.noaa.gov/products/predictions/30day/SSTs/sst_clim.htm

1981-2010 SST Climatology: http://origin.cpc.ncep.noaa.gov/products/people/yxue/sstclim/

- **The seasonal mean SST in February-April (FMA) increased by more than 0.2°C over much of the Tropical Oceans and N. Atlantic, but decreased by more than 0.2°C in high-latitude N. Pacific, Gulf of Mexico and along the east coast of U.S.**
- **Compared to FMA, the seasonal mean SST in August-October (ASO) has a stronger warming in the tropical N. Atlantic, N. Pacific and Arctic Ocean, and a weaker cooling in Gulf of Mexico and along the east coast of U.S.**

Data Sources and References

- Optimal Interpolation SST (OI SST) version 2 (Reynolds et al. 2002)
- NCEP CDAS winds, surface radiation and heat fluxes
- NESDIS Outgoing Long-wave Radiation
- NDBC TAO data (http://tao.noaa.gov)
- PMEL TAO equatorial temperature analysis
- NCEP's Global Ocean Data Assimilation System temperature, heat content, currents (Behringer and Xue 2004)
- Aviso Altimetry Sea Surface Height
- Ocean Surface Current Analyses – Realtime (OSCAR)

Please send your comments and suggestions to Yan.Xue@noaa.gov. Thanks!